A

TREATISE

ON

NAVAL GUNNERY.

PUBLISHED WITH THE

APPROBATION AND PERMISSION

OF THE

LORDS COMMISSIONERS

OF THE

ADMIRALTY.

BY

MAJOR GEN. SIR HOWARD DOUGLAS, BART.

K.S.C. C.B. F.R.S. *&c. &c. &c.*

SECOND EDITION.

LONDON:

JOHN MURRAY, ALBEMARLE-STREET.

MDCCCXXIX.

PREFACE

TO THE SECOND EDITION.

Having been informed, some time ago, through my Bookseller, and by some professional friends, that a new edition of the Treatise on Naval Gunnery was in demand, I lost no time in sending directions to the Printer to set up a fresh impression; and intimated to him, that a Preface or Introduction would be furnished, before the work could be got ready for publication. I have not, however, had it in my power to prepare this in the manner and to the extent which I wished and designed; and now, having received advice that the work is kept waiting for me, I am

obliged to send these sheets to the press in a shape for which I am conscious I ought to solicit some indulgence from the reader.

If the former impression had not been entirely run out, I should much have preferred to postpone going again to the press, until my return to England; being extremely desirous of leisure and opportunity, to give to the work a degree of study and attention, which, in my present remote station, and its numerous occupations, I am entirely precluded from bestowing upon the subject; and which prevent me from correcting and revising the press in a timely and proper manner. In this particular, however, the work will not suffer;—for I have much reliance on the attention and accuracy of the Printer; and should any errors escape his notice, they will be corrected by my learned friend the Rev. Dr. Inmann, Professor of Mathematics in

the Royal Naval College, who has kindly undertaken to revise the proof sheets.

As the body of the work is neither enlarged nor altered, there may not, so far, appear to the reader to be any necessity for a Preface.—It is precisely on this account that I consider one to be required:—I feel that it is due to the importance of the subject, to account for not having endeavoured to improve and enlarge the work, so to render it more deserving of notice, and more likely to be of use.

I have other reasons, too, for wishing to insert, in this edition, some introductory remarks. I have stated, in the first impression, that I was well aware of the objections that might attach to the measure of cultivating improvements in warlike practice, through the medium of the press; and I have explained the circumstances which, notwithstanding those objections,

led to the publication of the Naval Gunnery. The disadvantage to which I chiefly allude, consists in this,—that the service, for whose benefit suggestions are thus made, does not ensure to itself the exclusive, and (which is of great importance) the initial practical advantages, which such suggestions or inventions may be found capable of producing. It is true, on the other hand, that improvements in any practical science are seldom generally introduced, and can only be brought forward very slowly and very partially, through the medium of manuscript memoirs; and that, although the power of the press may circulate, abroad, much of what it may be very desirable to retain at home, yet it is by this mode only, that instruction or improvement can be effectually and usefully circulated and taught amongst ourselves. It must have been from this consideration,

that the Lords Commissioners of the Admiralty gave their sanction to the publication of the work.

In this view of the rival tendencies of publications on such subjects, it will readily be believed, that I was led to observe, with intense interest, the several notices which might be taken of my work, at home and abroad, for the purpose of ascertaining in what degrees of discredit, or of estimation, the treatise might be held, and the uses likely to be made of it; and if it should be favourably noticed abroad, to watch and compare the effects which might result from such notice and (probably adverse) uses, with those which might be preparing at home.

I am very sensible that it may be considered by some persons to be bad taste, or egregious vanity, in any author, to cite to the public any favourable notice which

may have been taken of his labours. At the risk, however, of incurring this charge, I find it expedient to refer to the notices which have been bestowed upon, and the uses which appear to be making of, the Naval Gunnery in foreign services, because there are indications that some of my suggestions and inventions may, some time or other, be tried against us. It becomes, therefore, a matter of the deepest interest to me, and it may be of some importance to the country, that measures should be taken to secure to ourselves the greater degree of *proficiency* at least, in any advantages which the several suggestions contained in that book may be found capable of producing; and it would only be upon well assured proof that the Treatise on Naval Gunnery, so far as it is used in other services, is leading them into error, that we should be guarded from reproach

hereafter, for not now cultivating, and endeavouring to improve, what has been suggested, with, at least, equal assiduity.

It has certainly appeared to many of those professional persons whom I first consulted, and who, in fact, encouraged and urged me to proceed in these my labours, that much remains to be done in some highly important matters which I have presumed to treat, and particularly in all that relates to the instruction of Naval Officers in the theory and practice of Naval Gunnery, (especially those who may not have been students in the Naval College,) and in the formation, instruction, and training of *seamen* Gunners, upon a basis sufficiently extensive to include in its benefits Master Gunners, Gunner's Mates, and a sufficient number of seamen Gunners, to act as Captains of Guns in a suddenly extended establishment for war;

thus to meet efficiently, and with every reasonable certainty, the first exigencies of service, which, unless some such means are kept in depôt or in reserve, must obviously be attended by serious disadvantage, either in draughting numbers of the best trained men from the ships of the peace establishment, and thus lowering that degree of efficiency in Gunnery which *they* will no doubt have acquired by practice, or of sending out new commissioned ships with crews entirely untrained to the warlike exercises.

The Naval Gunnery being now, in an extensive second edition, translated into foreign languages, and used as a Manual and School Book in our own and in foreign Seminaries, the author may so far be permitted to refer to these, as public evidences of professional acceptation, which may recommend his labours to the further

consideration and support of the Naval Administration.

In the French translation of the Naval Gunnery by M. Charpentier, élève of the Polytechnique School, and Captain in the Artillery of the Marine, and from several articles on the subject of Naval Gunnery in the Revue Encyclopédique having immediate reference to the suggestions contained in the Naval Gunnery, it appears that Schools for the instruction of Naval Gunners have been established in some of the chief Naval arsenals of France, and that a desire is very generally addressed to the Government, "que la nouvelle artillerie des flottes de sa majesté, soit exercée à la théorie et à la pratique de son art avec toute l'importance que commande l'urgence nationale de ce service,"* in the manner recommended in the Naval Gun-

* Translator's Preface.

nery. It also appears "que les platines à double tête commençent à étre adoptées, dans la marine française, que plusieurs bâtimens en sont pourvus."* Other recommendations are noted for trial, improvement and adoption;† and the work is used practically in other services likewise. I think I shall be considered to be doing justice to myself, and to my subject, in noticing these things.

FREDERICTON, NEW BRUNSWICK,
October 20, 1828.

* Charpentier's translation.

† Nous devons chercher à mettre à profit pour l'avenir l'avertissement que nous est donné ici—*Charpentier's Translation of the Naval Gunnery.*

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TO

THE RIGHT HONOURABLE

THE

LORD VISCOUNT MELVILLE,

FIRST LORD OF THE ADMIRALTY,

&c. &c. &c.

THIS WORK

IS, BY PERMISSION,

RESPECTFULLY DEDICATED

BY

HIS LORDSHIP'S

FAITHFUL SERVANT,

THE AUTHOR.

INTRODUCTION

TO THE FIRST EDITION.

AWARE of the objections that may attach to the measure of cultivating improvements in warlike practice through the medium of the Press, I must explain the circumstances which have led to the publication of this Work.

Having, during the war, made observations, and formed opinions respecting the state of Gunnery in the British Navy, which led me to reflect studiously how this important branch of our martial system might be improved, I occupied myself for some time after the close of the war, in composing this Work; and in Oc-

tober, 1817, transmitted it to the Lords Commissioners of the Admiralty.

The long absence of the Senior professional Lord (the late Admiral Sir George Hope) from the Board, and the changes which took place upon the lamented death of that distinguished officer, occasioned considerable delay in taking my papers into consideration; but I was soon afterwards honoured with "the thankful acknowledgement of the Naval Administration for the very able," (they were pleased to say,) "and valuable communication I had made;" but no decision was then formed as to the use that should be made of it.

In November, 1818, I was honoured with a further, and still more flattering, acknowledgement from the Admiralty, accompanied by a request, that I would per-

mit a Copy of my Work to be retained in the Admiralty Office, with a view to carry into effect the whole, or any part of my plans, hereafter, when those considerations and financial circumstances, which at that time prevented their adoption, might admit. To this communication I returned the following answer.

(Dated) Farnham, Nov. 29th, 1818.

SIR,

I HAVE had the honour to receive your letter of the 24th instant, in which you acquaint me, by Lord Melville's directions, that his Lordship and the Board think very highly of the manner in which I have treated the important subject of Naval Gunnery, in the several MSS. which I have addressed to the Admiralty—their approbation of many of the suggestions contained in those papers—and their request to be permitted to retain a Copy of the Work at the Admiralty, in order that they may be enabled to carry into effect the whole or any part of my plans, in the event of changes in those circumstances and considera-

tions, which at present prevent the adoption of my suggestions.

I am gratified by this communication; and beg you to present to the Board my consent to their Lordships retaining a Copy of my Work; to which I request copies of all my Letters, including this, may be attached, for the purpose of procuring reference to me, should I be living, at the time *any* adoption of my plans may be contemplated.

I had formed an intention of making a publication upon this subject; but considering this consent to the request which the Board has made, as inconsistent with the measure of publication, I willingly abandon that intention, unless it should have the approbation of their Lordships.

I have the honour to be,
&c. &c. &c.
(Signed) HOWARD DOUGLAS.

To Vice Admiral
Sir Graham Moore, K. C. B.
&c. &c. &c.

In answer to this letter I was soon afterwards acquainted by Vice Admiral Sir

Graham Moore, that he had "communicated my letter of the 29th November to Lord Melville and the Board, and was authorized to acquaint me, that their Lordships did not see any objection to the publication of my Essay on Naval Gunnery," which was accordingly soon afterwards returned to me, for this purpose, with the following letter from the Secretary of the Admiralty.

Admiralty Office, 25th Nov. 1819.

SIR,

MY Lords Commissioners of the Admiralty, having had under their consideration your Essay upon the Theory and Practice of Naval Gunnery, submitted to them in your letters of the 15th and 23d October, 1817, command me to express to you their Lordships' thanks for the communication, and for the attention you have paid to this important subject; and in reference to your intimation of causing it to be published, their Lordships further command me to acquaint you, that they have no

objection to your doing so, if you should think proper; and with this view, I am directed to return to you herewith the original Manuscript, and to add, that a Copy of it, together with your letters addressed to the Members of the Board upon the subject, have been retained in this Office.

I am, Sir,
Your most obedient
humble servant,
J. W. CROKER.

Colonel Sir Howard Douglas.

Upon the receipt of this letter, I applied for, and received Lord Melville's permission to dedicate my Work, in print, to his Lordship, as I had already done in MS., and I send it forth, conscious of its defects, as well as of my inability to treat the important subject in the way it merits.

NAVAL GUNNERY.

PART I.

ON THE ORGANIZATION AND TRAINING OF NAVAL GUNNERS.

When the navies of Europe, opposed to us in the late war, had been swept from the face of the ocean by the gallant achievements of the British marine, a period of triumphant, undisputed dominion ensued, during which our seamen were not, in general, sufficiently practised in the exercise of those weapons by which that dominion had been gained; but, in the pride and ease of conquest, were suffered, in many instances, to lose much of that proficiency in warlike practice which had been acquired in a long series of arduous service. No one seemed to doubt that the decided superiority which we had displayed in every action with a marine generally esteemed expert in gunnery, was owing to a degree of permanent perfection in our own system, which, animated

by the well-known gallantry of our officers and seamen, would always ensure us victory over the vessels of any other state, even in conflicts with superior force. Relying with too great confidence on this persuasion, we were led to despise expected foes whom we only rated on a level with those we had uniformly beaten; and to engage rashly in very unequal contests, with the ships of a power whose practice we have since found is not of that character which should render us satisfied with the condition, or indifferent about the improvement of our own.

Reviewing carefully our naval actions with European enemies during the whole of the last war, and comparing them with the battles which were fought in that which immediately preceded, there appears abundant proof that the navies of Europe had very much deteriorated in the practice of gunnery. In the war which terminated in 1783, the damage which our ships sustained, even in combats with nearly equal force, was, in general, much greater than in the actions of the late French war. It appears, indeed, that even in the later periods of Napoleon's reign, when he had certainly effected considerable improvements in his marine, the state of practical gunnery was still so

wretched, that we have seen ships, fully officered, superbly equipped, and strongly manned, playing batteries of twenty or thirty heavy guns against our vessels, crowded with men, without more effect than might easily have been produced by one or two well-directed pieces; and we have seen some cases in which heavy frigates have used powerful batteries against our vessels for a considerable time, without producing any effect at all.

The danger of resting satisfied with superiority over a system so wretched as this, has been made sufficiently evident. It consisted more in relative than in absolute excellence. We became too confident by being feebly opposed; then slack in warlike exercise, by not being opposed at all; and lastly, in many cases inexpert, for want even of drill practice; and herein consisted the great disadvantage under which, without suspecting it, we entered, with too great confidence, on war with a marine much more expert than that of any of our European enemies.

It may, at first sight, appear objectionable to preface a work of this nature with such an admission.—It did so, at first, to myself; but a little reflexion will convince us all, that this is, in policy, as in fact, the very best, and the

most satisfactory apology we can make for any disappointments we may have met with. We are not the first people who have suffered by reposing too confidently in the power and pride of triumph.—We can admit this explanation without a blush; it throws no stain upon our national character; for never was the heroism of our officers and men more splendidly displayed, than in those unequal conflicts in which they were obliged to yield to superior force, which they had engaged with the fullest confidence of success: it conveys no reproach to our rulers, for it arose from that daring spirit of professional ardour which we had ever applauded by general acclamation; and who shall say that they ought to have restrained, before a trial, that gallant confidence which had been rewarded with uniform success, in many conflicts, apparently more unequal? This explanation also permits us to indulge the most pleasing anticipations, if we make proper use of what we have experienced; for such of our ships as *did* possess a good system of gunnery, triumphed, even against superior force, as it is thus proved, they will ever do, when this most important branch of our practice becomes a matter generally cultivated in the profession.

Other explanations have been given to the

public, founded on a minute balance of comparative bulk, dimensions, weapons, number and quality of men, &c.; and in such scales the most trifling make-weights have been used, to account for and justify the results of every unsatisfactory action. This very discouraging and spiritless creed would stake physical power, numerical force, and material weight against each other, respectively, in apologetical terms in which we have not hitherto been accustomed to view such cases. It recognizes, attempts to justify, and would reconcile us to the necessity of yielding to superior force, even without inflicting ravages commensurate to our powers; it would bear the deduction, that to engage a larger vessel is an hopeless enterprize, unnecessarily wasteful of human life and material means. It makes no allusion to, no stand for, conveys no expectation of what may reasonably be expected to result from, superiority of address in warlike science and practice. It endeavours to establish a new, and, as it appears to me, a dangerous and humiliating doctrine, which, it cannot but be perceived, is much more complimentary and encouraging to others, (for why else did we not declare it before?) and much more derogatory and discouraging to ourselves, than to admit the exis-

tence of deteriorations and partial defects in our system, which it is in our power to remedy. Comparative views of effect and warlike skill should be taken in judging all such cases, as well as statements of comparative bulk and force. The relative qualities of skill and practice may be judged of, making every allowance, even in the most unequal conflicts. If a vessel meet a larger, and, though ultimately captured, think it due to the honour of her flag to try the effect of a few rounds, she should leave marks of her force and skill upon the larger body, if she, the smaller, be hit at every discharge. If not, she does but salute her enemy's triumph; and in proving disregard of danger, discredits her own system. Do not let us blink this question. To account for this, it has often been said, in metaphorical allusion to our pugilistic contests, that a boxer overmatched is soon *abroad* (bewildered), and knows not where to place his blows. But unless it were possible to stagger with fear men who never felt its approach, or to blind every man in the ship, this cannot apply; and the admission is full of danger. It is not disgraceful that a vessel should be forced to yield to another of superior force; but that the enemy should not be made to smart for his conquest, if any resistance

have been attempted. Yet the devoted vessel cannot in justice be blamed, so long as naval gunnery is not a matter of professional cultivation, and absolute obligation. If the gunners of a vessel mistake the elevated sight of their arms (carronades), for the point-blank line; and, when close to their enemy, fire at an elevation of three and a half degrees, what can be expected? This circumstance did, however, actually occur; and I have witnessed, and could name distinguished authorities to prove, the existence of much more serious errors. Is it not better to state and admit such facts and explanations, and study how to remedy them, than to attend to details and estimates of numbers, strength, and matèrial, which do not contemplate any improvement of *system?* We are right to build large frigates; but it is, we may depend upon it, more important to consider in time, how they are to be provided, at the beginning of a war, with officers, gunners, and at least a proportion of seamen, trained to warlike practice.

The material of our navy is in the finest possible condition. Our ships are greatly improved in every feature of strength and warlike quality. Our ordnance is the best in the world; every species of store and equipment is perfect. We

possess excellent seamen, trained by the operations of our commercial navy. Our officers, many of them educated at public expense, are good navigators, excellent astronomers, and are full of energy, activity and courage: but these elements and qualities are not sufficient to constitute a good *ship of war*, unless the knowledge of warlike science and practice be added; and that in a manner to become immediately operative at the commencement of a rupture. The practice of a long war, and the talents of many distinguished officers had formed some expert crews of gunners: but these benefits were partial; and we shall undoubtedly lose, in peace, all or much of that proficiency, unless we take special care; and shall have again to struggle through years of difficulty, only to attain what we may not only secure from decay, but most certainly further improve, and even render permanent. After many years of war had afforded us ample opportunities of practice, and yielded us many splendid victories, we were, in some instances, severely disappointed.—Let us consider well, what may be the case, when, after a long peace, we send out fresh commissioned ships, manned with untrained people, for immediate battle. How many gallant officers have gone forth, with splendid reputations and the

sacred honour of the British flag, depending upon crews on whom no reliance could be placed, excepting for courage and self-devotion! I humbly endeavour to provide a remedy for this; and the reasons which I shall offer in support, will, at least, advocate the case of every man who has been, or who may be, exposed to such perils of character: and I take occasion to assure the officers of the navy who may peruse this work, that any remarks on public events which I may think it necessary to make in the course of my essay, are not quoted to criticise, but on the contrary, to justify, or account for operations which were always most gallantly undertaken, and which could not perhaps have been better executed, with the means and qualities they commanded.

There cannot be any doubt of the vast advantages that would result from enlightening by theory, and training by practice, during peace, as large a proportion as we can of those who are to command and serve our naval ordnance, in war. It is impossible indeed that we should be disappointed in the conviction we feel, that splendid advantages would result from such a measure. With men imperfectly trained, no nicety of practice can be attempted, or expected. Many improvements which would ap-

pear simple, and might be easily practised by well formed artillerists, may be considered complicated and impracticable by people who may, perhaps, be quartered to their guns *for real action*, as one of their first artillery exercises. Thus I have often heard it enforced, that nothing that is not coarsely simple can be practised in Naval Gunnery, and that no innovations should be attempted; and the difficulty which my father experienced, even from officers, in procuring the adoption of locks, and many other improvements which he made in naval ordnance, are proofs how far the want of some general cultivation of the science and art of gunnery are impediments to the introduction of improvements, which, instead of being resisted, would be eagerly received, were our people taught to estimate them. What would now be the condition of our admirable land-service artillery, were it not for the institution which cultivates theory, and the system which has perfected the practice? It would have remained far behind in the progress to improvement; and, instead of being the very best, might have been, perhaps, the worst artillery in Europe. Suppose that, at the commencement of war, instead of taking the field with a well trained corps of artillery, we were merely to

turn over multitudes of able-bodied men to that duty, (as is the case in our naval artillery,) and hurry them off for action, without more training than may be acquired in the short interval between enrolment and real service; and, if after the interval of a long peace, under officers destitute of experience, unacquainted with science, and rusty in the practice of former wars. —To such a corps, much of that nicety of practice which is, at present, admirably and easily executed, would appear mere refinement, as impossible to be observed, as it is to introduce or hope for expert practice from our naval artil lery, at the commencement of a war particularly. —Should the improvement of Naval Gunnery be less an object of national importance, than the instruction and training of our *land*-service artillery?

Whatever plan may be adopted for the improvement of Naval Gunnery, it should be calculated to instruct officers, master-gunners,* gunners' mates and their crews; and no measure, that provides only for the drill of the men, can effectually improve the service practice: for the mere dexterity of a few privates will do little, unless directed by cultivated and well exercised intelligence on the part of the officers com-

* To avoid mistake we shall designate the gunners of ships *master-gunners*.

manding in the ship's batteries, and assisted by a good crew of practical gunners.

The complements of men allowed for vessels in our service do not admit of larger establishments of landsmen for the fighting duties, than are included in the present proportion of marines and others; and, consequently, the people trained to naval gunnery should be capable of executing the duties of seamanship as well as the military exercises; and were our crews made more numerous hereafter than they now are, the men trained to the practice of gunnery should, nevertheless, be *seamen*.

To instruct the rising class of officers in gunnery, a short course of theoretical instruction, showing all the established principles of the science, should be introduced at the Naval College. Gunnery should also be made an item in the examinations for promotion. To instruct a proportion of officers, midshipmen, master-gunners, gunners'-mates, and some seamen, in the practice of gunnery, *Depôts of Instruction* should be formed. So much depends upon the nature and composition of these establishments, that I must be permitted to show, at some length, the reasons which have guided me in making the following suggestions; and the objections which appear to me to attach, in great

forcc, to some measures that have been contemplated.

In forming establishments of instruction in the practice of Naval Gunnery, it is most assuredly important and indispensible, that the vast opportunities which situations of instruction and constant practice offer for the cultivation of improvement, and for the acquirement of great proficiency, should be given to those only who are hereafter to practise, in the profession, on service, what they cultivate and teach in peace. To form the depôts of instruction, therefore, of any but naval characters, would be to confer the distinctive encouragements awarded to the cultivators of this great branch of naval science, and the proficiency that must be acquired in teaching it, to a body who could not be called upon to apply those qualities to actual service, without serious and evident inconveniences; for *naval officers* and *seamen* are, and must be, our only real-service *Naval Gunners*. If depôts of instruction were to be formed of naval characters first drawn in to study, then appointed to teach, and, by circulating in the service, held always ready to practise in war, what they have acquired in peace, the vast advantages resulting from the establishment of depôts of instruction would

overflow upon, and by degrees circulate through, and improve, the warlike science and practice of the whole naval service.

In this view it may be pronounced, with perfect certainty, that the application of the *Marine Artillery* to instruct seamen in Naval Gunnery, would prove extremely prejudicial,—destructive indeed of those facilities which should be offered to naval officers to cultivate artillery knowledge. The corps of Marine Artillery was formed during the late war, in consequence of some difficulties and disagreements which took place in the sea-mortar service when the royal artillery was attached to it. The Marine Artillery has been raised to a condition of great excellence by the zeal, talent, and gallantry it possesses; and has certainly performed all the service that was contemplated at its formation. I have witnessed its efficiency on service, and bear willing testimony to all the talent it has put forth, and all the distinction it deserves. It is well constituted, thoroughly instructed, and ably commanded. It is either a corps of good infantry, scientific bombardiers, or expert field-artillery. Let it retain all these characters, by being kept for mortar service afloat, or for land-artillery service on desultory coast operations; but to apply or extend it, in any way, to

instruct *seamen* in gunnery, instead of throwing this duty entirely into the hands and heads of naval officers, master-gunners, and their crews, is, it appears to me, calculated to repress and extinguish an ambition now very general among naval officers, to make themselves masters of this important part of their duty; and in this view it may fairly be considered, that the proficiency which the Marine Artillery has acquired in Naval Gunnery, is just so much detracted from the body to whom its cultivation should exclusively belong; and that all the expertness which this corps must further acquire, if the proposed measure of making it the organ of instruction be carried into effect, is just so much withheld from the real service practitioners, on whose conduct and proficiency the honour of our flag and the interests of our country greatly depend.

The fundamental principles then that should form the basis of any measure that may be adopted for the improvement of Naval Gunnery, are, that no plan which does not provide for instructing officers, master-gunners, gunners'-mates, and their crews, as well as drilling seamen in the exercise, can effectually improve the service practice;—that to assign duties of instruction to any who are not of the body

taught, must interfere, more or less, with the real-practice utility of the great object in view; —that our only real-service naval gunners are, and must of necessity be, naval officers and seamen;—that marines cannot be employed afloat in greater numbers than at present;—and that to render permanent and effectual the benefits that would result from the formation of Naval Depôts of Instruction, a proportion of intelligent seamen should be engaged for a term of years, and formed into a permanent body, from which the important situations of master-gunners should be filled; and which, in a more extended form, might be made to furnish hereafter a considerable number of expert seamen gunners to act as captains of guns; or, if not sufficiently numerous to do this, capable, at least, of soon drilling to the established system, the ordinary crews of those vessels into which these trained men may be draughted.

The plan of drilling ships' crews by the marine artillery yields no permanent benefit. When the vessels which have been three years in commission are paid off, and the seamen dispersed, what permanent naval advantages do we reap from the instruction that may have been given? The instruct*ed* are thrown at large upon the world—the instruct*ors*, further improved by the

lessons they have given, are still not real-service naval gunners; and it may happen that the system and expertness which they may have taught, will, in numerous instances, be carried to the aid of foreign nations, at the very time we most require them ourselves. Ship after ship may be commissioned, as during peace, the crews drilled, and, on the expiration of their servitude, dispersed. But all we can hope for from such a plan is, that by thus introducing successions of trained gunners into the mass of merchant service, we *may* hereafter, in war, recover some for the King's navy; but in the mean time the rising generation of naval officers, of whom but a few can be employed afloat, are left uninstructed, master-gunners and their crews unimproved, and, most certainly, no permanent advantages gained.

Now to remedy these serious objections, we should first engage a certain number of seamen, expressly for the service of the gunner's crew, for periods of five or seven years; renewable at their expiration, attaching a small increase of pay to each consecutive re-engagement. The advantages held out to volunteers should be, that master-gunners, gunners'-mates, and a certain number of seamen gunners, will, eventually, be incorporated; and that regular ad-

vancement in that department will hereafter take place, according to merit; so that seamen gunners may, if they can read and write, consider themselves in the certain road to gain, according to their merit, situations of gunners'-mates, and master-gunners of ships. Seamen gunners to receive 1*s.* 4*d.* per diem, and to share prize-money as gunners'-mates do now, or with some other rank, superior to able seamen.

The practicability of forming such an institution resolves itself into this—whether, upon these advantages being made known, a sufficient number of volunteers can be procured to commence such an establishment.* The experiment might be easily tried; but the proposal should be accompanied with an explanation that the system provides, eventually, a term of relief, or residence on shore, for men so incorporated. If the experiment answer the confident and authorized expectation that may be entertained of its success, a selection of naval officers, the best practitioners of the late war, should be named, to conduct the Depots of Instruction;

* It has been suggested to me, by a gallant Admiral, that boys who may be educated at the Asylum, or by the Marine Society, might, after practice shall have made them able-seamen, become very fit persons for service in this department.

and I have every reason to believe that some very distinguished officers would come forward to commence such a system. In this way a number of trained men would always be retained in the service—successions of commanders, and many officers who cannot be employed afloat in a limited peace establishment, would, at the trifling expense of full pay, be improved in this important branch of their military duties; master-gunners and gunners' mates would be trained; and a permanent stock of seamen gunners brought up, to fill hereafter these important offices; and should it be extended ultimately in the manner I propose, it would furnish besides a considerable number of very expert captains of guns.

When a sufficient number of men are procured to form one depot of instruction, a proportion of officers, properly proficient in a course of gunnery, and in a general system of exercise, should be appointed.

One captain, three or four lieutenants, and a certain number of midshipmen, master-gunners, and gunners'-mates, should be nominated to a division; and, if the experiment succeed, other divisions of instruction should then be established at the principal arsenals, and the

whole placed under the superintendence of a Rear Admiral.

All seamen gunners should be made perfectly acquainted with the duties of every man, in the exercise of all natures of ordnance, with reduced complements as well as with the full crew; so as to be perfect masters of every fresh arrangement that may be required to replace casualties.

A level space proper for a good range, should be fixed upon, and a sufficient number of guns and carronades mounted in batteries similar to ships' sides, and consequently placed at various and corresponding heights above the horizontal plane.

Young officers, master-gunners of ships, and gunners'-mates training for these important, situations, should be instructed in the following matters:—the names of the different parts of a gun and carriage:—the dispart in terms of lineal magnitude and in degrees, how taken;—what constitutes point-blank, and what line-of-metal range;—windage, the errors and loss of force arising from it, (Part II. case iv. art. 45. et seq.) showing also the importance of preserving shot from rust (art. 74.);—the theory of the most material effects of different charges of powder, applied to practice with a single shot, (Case II.

art. 33.) also with plurality of balls (art. 41. to 44.) showing how these affect accuracy, penetration, (Case IX. art. 97. to 103,) and splinters, (35 and 100.) Gunners of ships should also be qualified to judge of the condition of gunpowder by inspection; to ascertain its quality by the ordinary tests and trials, as well as by actual proof; and these, as I shall show hereafter, (Part IV.) are very indispensable qualifications.

Master-gunners should also be instructed in the laboratory works required for the naval service—such as making rockets for signals; filling tubes, new priming them in particular; making and filling cartridges; precautions in airing and drying gunpowder; care and inspection of locks, choice of flints, correct mode of fixing them, &c. &c.

The officers, master-gunners and those training for such situations, will then proceed to the practice of gunnery, together with the seamen gunners who may have been previously instructed in the exercise.

The practice should be taught, with every degree of precision, at the range on shore, in order to show the actual ranges of ordnance, when not affected by the motion of a ship, and thus discriminate between the errors of gun-

nery, and those which necessarily arise from the floating motions. Elementary instruction in practical gunnery cannot indeed be properly given *afloat;* it is absolutely essential that the principles of the practice be shown *on shore.*

Practice should first be taught with the different natures of naval ordnance, single shotted, at point-blank distances, with the service charge; then at line-of-metal ranges, and at some intermediate and greater distances, against large targets or screens, some the height of single, others of two-decked ships, and fitted with poles to represent, in height and position, the masts of an enemy. This, for reasons that will be given in Part IV. when we come to treat of the practice, is very important. Practice should then be made at the same distances with *two* shot, to show the great uncertainty of this practice at long ranges: and with reduced charges, to show the corresponding ravages that may be occasioned by splinters.

Practice should then be carried on, at every hundred yards from 100 to 1000, with all natures of guns and carronades in ordinary use, to show their comparative merits and powers, in regard to accuracy and other effects (Case VII. art. 77. to 96.) Instruction should also be given in mortar practice; and in shell practice from guns,

with common shells and also with spherical case.

When expert in the school-practice on shore, the gunners should practise afloat from a hulk kept for that purpose at each depot. They will thus learn the comparative uncertainty of naval fire; and, consequently, be prepared to receive, and observe, this important maxim—that minute accuracy and intelligent quickness are more essential in Naval Gunnery, than in the land-service; for although it may not be possible to attain equal precision, yet every approximation that can be made towards it, by expertness or simple expedient, will tend, in some degree, either to correct or reduce those errors which arise from the floating motions.

As soon as one set of seamen are returned complete in exercise and practice, they should be transferred to commissioned ships, and there drill the seamen engaged in the ordinary way, according to the general system; so that in this respect they would be as well trained, at least, as by the contemplated plan; and all the permanent advantages of the proposed system would be so much gained.

Fresh seamen should be engaged as gunners, and drawn in to the Depot of Instruction, in proportion as trained men are turned over to

the guard-ships. These again should, by degrees, transfer to the cruisers a certain proportion of the trained gunners that will have been received from the depots; which however should, together with the guard-ships and home cruisers, always retain a sufficient number of trained men for new commissioned ships, in the event of sudden armament. In this manner vast facilities and advantages would be experienced in fitting ships, and in rendering them more immediately efficient. The plan now suggested would provide people not only qualified to assist in fitting the ship, but also to assist in working her; not only qualified to drill to gunnery the fresh hands—but to examine and arrange all the ordnance equipment—and very soon to make that ship, if properly commanded, a *good man of war*.

In all departments of warlike organization, depots are allowed to be the very hearts of the system, by which improvement is cultivated, circulated, and established. In all services this is recognised and observed; no body can be permanently good, no system uniform without them. It is to this general measure that the service efficiency of every branch of our army is mainly to be attributed. It is this which supports the uniform systematic excel-

lence of the whole machine, however remote some of its parts may be. It is from a similar system, connected with the naval profession, that the marines are what they are; and which has so much improved, perfected indeed, the Marine Artillery. If instead of applying it to naval artillery duties, a corps of naval gunners had been formed, composed of seamen and officered by a succession of naval officers, there can be no doubt that its proficiency would be equal to, and its utility, as Naval Artillery, infinitely greater, than that of the *Marine* Artillery. Detachments of this corps were embarked on board the ships of the squadron that was sent out last summer on a cruise of exercise and practice; and it is no uncommon thing for naval officers fitting out ships to apply for detachments of Marine Artillery to drill their seamen to the gun exercise. If such detachments had been, or could be drawn from a permanent body composed of *seamen*-gunners trained by *naval* officers, instead of marines, can there be any comparison between the influence of the two systems, on the practice of Naval Gunnery?—If the squadron in question had been to sail on real service, instead of a peaceable cruise, which system would have

been most efficient? The Marine Artillery have their peculiar duties; but to extend them to any interference with naval *gunnery*, would be most injurious. For the same reason that the Marines have their divisions, the Royal Artillery their schools of practice, and every regiment its depot, naval gunnery should have its permanent seat of instruction, and store of trained men. The advantages that would result from such an establishment are beyond calculation. These depots would become the resorts of zeal and talents—the nurseries of improvements; vast numbers of young naval officers of all ranks would resort thither at their own expense. Such is precisely the opportunity which the naval service wants in this branch of the profession. Improvement might then be cultivated without pursuing it through other departments, as at present;—Naval officers would find a field open to them, which is now occupied by others. Courses of practical instruction might be given to any number of young officers who might choose to attend. Naval gunnery would become, as it most certainly should, an organized department of the naval service, under the direction and controul of the naval administration; and I feel most

enthusiastically certain that this simple measure would lay the foundation of a system which would soon be cultivated to perfection, by the professional genius and zeal which it would call into action.

As to the extent to which this plan may be carried, present expense and future circumstances must be consulted; but the system might be commenced without incurring charges of consideration sufficient to defeat this great national object.

The merits of this plan do not depend upon the limited extent to which we may be obliged to confine it, at present, on account of the difficulty of making financial provision for a more general operation.—If it be plainly calculated to do some good, it should not be rejected because, for contingent reasons which attach not to its merits as a system, it cannot, at present, yield its full benefits. If it be capable of training people sufficient to furnish master-gunners, gunners'-mates and captains of guns for half the number of guns (i. e. a fighting side) of ten sail of the line and thirty frigates, (about 1000 men) it should not be abandoned because, on account of the expense, it cannot supply double the number. The adoption of a good sound

system is the present consideration, not its immediate extension. If we found our measure upon a good professional principle, the superstructure may be raised gradually, in proportion as we may require it. The question for consideration is, whether the plan which is suggested does not provide a good professional system for instructing officers, midshipmen, master-gunners, and gunners'-mates;—for training a proportion of seamen as captains of guns, as well as for drilling seamen engaged in the ordinary way: whether such a measure would not eminently tend to encourage the professional cultivation of artillery knowledge, forming a good sound system, in which extension of benefit may be made to accompany extension of force. If it promise such advantages, it will be cheaply purchased by any expense that may attend it. Were it an experimental measure that could not be commenced, without first committing the country to vast preparatory expense, we might hesitate about making the trial; but the system may be instituted at a rate that would not amount to the expense of adding a 20 gun ship to our establishment.

If, by way of commencement, *one* depôt were

formed, the following is an estimate of the expense.

	Average half pay per day.		Average full pay per annum	Diff. of expense per an.
	s.	d.	£.	£.
Captain	12	6	552	324
4 Lieuts.	As the average full pay very nearly balances the half pay of 6*s.* a day, it is proposed to pay the Lieutenants as 1st Lieutenant of ships, viz. 11*l.* 10*s.* per mensem, on account of the expense of living on shore. 6*s.* each		138*l.*	114
30 Midshipmen at 3*l.* 9*s.* per mensem -				1345
Lodging 1 Captain at 12*s.* per week - -				31
4 Lieutenants at 10*s.* per week				104
150 1st Gunners at 1*s.* 4*d.* per day				3650
150 2d Gunners at 1*s.* 2*d.* per day				3193
Provisions for 300 Gunners, rate not known				
Expense of Hulk for reception of 1 Lieutenant, 30 Midshipmen, and 300 Gunners - - - - - -				
Total, exclusive of the two last items, -				8761

As the Marine Artillery *is* established, some of their best non-commissioned officers should, at first, be attached to each Naval Depôt as drill-masters; but, hereafter, these situations should be held by some intelligent seamen-

gunners, to be called *acting master-gunners*, to receive 4*l*. 12*s*. per mensem, (the pay of gunners to sloops,) and to be promoted, on proper occasions, to master-gunners of ships.

I hope I have succeeded in convincing the reader that the improvement of naval gunnery will mainly depend upon thė character of the depôts of instruction. Whether, therefore, the measure of engaging seamen as gunners fail, or be rejected on account of expense, still my reasoning on the character and composition of the establishments of instruction attaches in full force; for whether seamen be raised in the ordinary way for three years, and drilled as at present, or be engaged for a longer term, and trained as naval gunners in the manner I propose, there can be no reason why an accessory body should be appointed to teach them, instead of employing in this way the members of the profession to which the practice really belongs; and to this indispensable provision I shall have again to revert in the following sections.

PART II.

ON THE THEORY AND PRACTICE OF GUNNERY, MORE PARTICULARLY APPLIED TO THE SERVICE OF NAVAL ORDNANCE.

1. THE discoveries made by Robins, Hutton, and others, in the science of gunnery, and the celebrated ballistic experiments from which many important laws have been deduced, are little known to purely practical men; or rather are only known to those whose scientific qualifications enable them to glean the principles from a great mass of very abstruse matter.

2. Through ignorance of those laws which have already been established, and consequently unacquainted with the correct road by which to seek improvement, we have frequently seen important maxims infringed, in construction, armament and equipment; and many useful practical deductions which have already been obtained, lost sight of, or violated.

3. To no branch of our general service is a knowledge of the principles of gunnery more essential—more indispensable, than to our naval

artillerists; and the importance of giving them every facility to study the theory which should regulate their practice, cannot be disputed. It is true that the construction of the gun and the regulation of its equipment depend not on them, but are determined and arranged by the proper authorities in the various departments of the ordnance; and that tables of ranges formed from media of many sets of experiments are sufficient to guide artillerists on all ordinary occasions; but in the infinite variety of circumstances under which our navy is called to act, afloat and on shore, a knowledge of the theory of gunnery cannot fail to be of use to officers on ordinary service, and under many special circumstances which they may not find in the tables, or even contemplated in any practical memoranda they may have collected.

4. To disseminate this knowledge to naval officers, in a full, regular course of theory, would be difficult, and is perhaps unnecessary; but a general conception of the established principles of the science is indispensable, to enable the reader to receive with faith, and comprehend clearly, the practical deductions that will be given in the course of this essay.

5. The determination, by theory, of the precise path or curve described by a projectile in

air, is a problem so difficult, that it could not, even if solved, be of use to practical artillerists, on account of intricacies of calculation which are quite inapplicable to actual service. But although our practice, under ordinary circumstances, may be conducted with tolerable certainty according to the tables of ranges that have been published, yet no director of artillery, by which I mean no officer, should be ignorant of the principles upon which those tabular cases are founded, nor of the more important discoveries in gunnery, which relate to construction, armament and effect. In adopting the practice noted in their memoranda, therefore, it cannot but be important, that officers should have some idea of the velocities and effects due to the charges they use—the principles upon which those charges have been regulated, and the effects of varying them. It cannot but be important that naval officers, at whose discretion, and on whose application the equipment of vessels as to nature of gun is frequently regulated, should know the laws of the action of powder in guns of different lengths, and in charges of different quantities; also the effects of shot of different weights or densities, of single balls, and of plurality of shot. Officers should not be ignorant of the laws of the pene-

tration of shot of different sizes, fired with different charges; nor of the effects of the air's resistance on projectiles discharged with different velocities, and varying according to the degree of celerity and the magnitude of the body. The investigations respecting the effects of resistance have been of vast importance, in correcting that erroneous theory which disregards the resistance of the air; but which hypothesis is still considered, by persons ignorant of the true theory of gunnery, as regulating our practice. Were this the case, the ranges of military projectiles might easily be solved according to the beautiful properties of the parabola, which, however, are of little use in practical *gunnery;* but as this theory affords some useful deductions for particular cases in *mortar practice*, and is, besides, the previous step in the ordinary course of instruction, I shall first explain the theory founded upon the parabolic properties.

6. The parabolic theory of gunnery proceeds upon the supposition that the air does not resist the flight of the body, and consequently that the projectile motion, in the direction of the tangent, would be uniform. That is, if a body be projected in any direction, A B, Figs. 1. 2. Plate I., it will describe equal spaces in equal

times, and suffer no diminution of velocity whatever, in that direction, to the end of its flight. Whilst this force is operating in the direction in which the piece is pointed, the projectile is continually falling below the line A B, by the action of gravity, in spaces proportional to the squares of the times of acting. In the first portion of time, A D, it will be found at 1, in the second at 2, in the next at 3, and so on, till it meet the horizontal line A C; when it will have passed through a space equal to H I, by the action of gravity, in the time required to reach H with the uniform projectile velocity acting singly.

7. Now it is a property of the parabola that the externals D 1, E 2, F 3, G 4, &c., are proportional to the squares of the intercepted parts of the tangent, that is, to the squares of A D, A E, A F, A G, &c.; but the spaces D 1, E 2, &c., through which a body falls freely by gravity, are as the squares of the times A D, A E, A F, &c.; therefore the points 1, 2, 3, 4, &c., lie in a parabolic curve, and consequently the path of the shell or shot is a parabola.

8. From this theory we obtain the following deductions; 1st, That the horizontal velocity is the same in every point of the curve; because it is in a constant ratio to the motion in A B,

which is uniform. 2dly, That the velocity of the projectile in any point 1, 2, 3, &c., in the direction of the curve, is as the secant of the angle of its direction above the horizon: for the motion in A X is constant: and A X : A D : : rad : sec. of the angle A. 3dly, In the direction of gravity, or perpendicular to the horizon, the velocity is to the first uniform projectile velocity, as the double of H I is to A H: for the times in H I, A H, are equal; and, with uniform velocity, equal to that which is acquired in the descent H I, the body would describe twice that space in the same time. Now the spaces described with uniform velocities, being as the velocities, the space A H : 2 H I : : velocity at A : perpendicular velocity at I.

9. According to the parabolic theory it would appear that the cases of gunnery may be determined from the following postulates:

1st, That there are two directions, or elevations, in which the same projectile velocity will give the same horizontal range, viz. any angle and its complement.

2dly, That the greatest horizontal range is when the double of the angle of elevation has the greatest sine, that is 45°. Fig. 2.

3dly, That with equal velocities, but at different elevations, the ranges are as the sines of double the angles of elevation.

4thly, That when the elevations are the same, but the velocities different, the ranges are as the squares of the velocities.

5thly, That the times of flight are as the sines of the angles of elevation.

10. But it is found that these postulates do not hold true in practice, and that the greater the projectile velocity, the greater is the departure from this theory. Thus, although with large shells, and velocities of only 2, 3, or 400 feet in a second, (to which the resistance of the air is, comparatively, inconsiderable,) the different cases of gunnery may be solved, with tolerable accuracy, according to the parabolic theory; yet, with the greater velocities and smaller projectiles, it is found to be quite erroneous. The range cannot be determined from it, nor does it furnish any correct means of computing the velocity of projection; which, if the theory were true, might be done, by observing the time of flight, or measuring the range; and then assigning that velocity, which, according to the theory, would produce that range or time of flight.

11. This method, then, of assigning the projectile velocity being fallacious, the celebrated Mr. Robins instituted some very ingenious experiments with his *ballistic pendulum*, to determine the initial velocities of shot, (that is, the

velocities with which they issue from the piece,) by which, together with the laws of resistance, every thing relating to gunnery might be determined.

12. Mr. Robins's experiments formed a new era in the theory of gunnery; but having only used musket barrels, it remained a great desideratum to repeat experiments, upon the same principle, on a much larger scale than the means of a private individual could afford. The prosecution of this important investigation was put into the able hands of Doctor Hutton, professor of Mathematics in the Royal Military Academy, to whom the country is so much indebted for the high state of theoretical knowledge which the British artillery possesses. These experiments were commenced in the year 1775; and a copy of the report being presented to the Royal Society, was honoured with the gift of the annual gold medal. The doctor carried on a second series of these experiments in the years 1783, 4, 5, &c.

13. The ballistic pendulum, Fig. 3. Plate I., is composed of a large block of wood, suspended by iron rods, so as to swing on its axis upon receiving the impact of the shot discharged into it, for the purpose of ascertaining its velocity.

14. It is a well known principle in the colli-

sion of bodies, that if a body at rest be struck by one in motion, the momentum, or quantity of motion, will be the same after the stroke as it was before; and when the moving body enters the other, that the product of the sum of the two weights into the velocity of the body which receives the stroke, is equal to the product of the weight and velocity of that which gives it. In this way very great velocities being reduced to those of two or three feet in a second, may be measured by the vibration of the pendulum according to very convenient and accurate means.

15. A shot fired into the pendulum will penetrate to a certain depth, and cause it to vibrate in a greater or less arc, according to the force of the blow. The arc of vibration was determined in Robins's experiments in a manner not very satisfactory; but, among the other improvements which Doctor Hutton made in the machinery, he applied a small pointed piece of iron, P, Fig 3, under the block, to trace the arc of vibration in a circular groove of wood, A B, filled with a little soft grease. The chord of the arc of vibration was determined by a line of chords laid down on the upper surface of the wooden arc, from which, and the radius of the arc described by the centre of oscillation, the

versed sine of the arc described by that point was found; for the chord is a mean proportional between the versed sine and the diameter, by a property of the circle. It is from the velocity of the point or centre of oscillation that we are enabled to determine the velocity of the shot, and hence it is of the first importance to ascertain its precise position.

16. The centre of oscillation is that point in which, if the whole quantity of matter in the pendulum could be concentrated, the time of vibration would be the same as that of the whole pendulum. The distance of this point from the centre of motion, or axis of the pendulum, may be determined by counting the number of vibrations the ballistic pendulum makes in small arcs in a given time; then, knowing the length of a pendulum required to vibrate seconds in the given latitude, the distance of the centre of oscillation from the point of suspension may easily be found, since the lengths of pendulums are, inversely, as the squares of the number of vibrations made in the same time. That is, if a denote the number of vibrations in one minute, and p = the length of the seconds' pendulum for the latitude of London, then $a^2 : 60^2 :: p : \frac{3600\,p}{a^2} = \frac{3600 \times 39\frac{1}{8}}{a^2}$ the distance, in inches, of the centre of oscillation below the axis.

The distance of the centre of gravity from the centre of motion of the pendulum was ascertained experimentally, by balancing the whole pendulous apparatus on a fine edge.

17. If the pendulum at rest be struck by a shot, and the vibration be marked, the velocity of the point of oscillation may be easily determined from the versed sine of the arc in which the block is caused to recoil. For it is well known that if a pendulum be lifted to any height in its arc, and then be let fall, the velocity at the lowest point will be the same as that acquired by descending freely through the versed sine, or perpendicular height of the arc; and, abstracted from friction and resistance, *that* velocity would be sufficient to cause the pendulum to ascend through an equal arc on the other side. Therefore, if the versed sine of the arc in which the shot causes the pendulum to rise be found, the velocity of the pendulum is known, since it is that which a body would acquire in freely descending through that space.

18. Having thus ascertained the velocity with which the pendulum is caused to move by the impact of the ball, and the quantities of matter of both being known, the velocity of the ball may be found thus; as the weight, or quantity of matter in the ball, is to that of the pendulum

and ball, so is the velocity of the pendulum to the velocity of the ball.

19. In this popular description it is only necessary to mention, that corrections are made for the change of the centre of oscillation by the accession of the ball to the pendulum, and for the distances of the centre of gravity and point of impact from the centre of motion of the pendulum. The effects of friction and resistance were also allowed for in Doctor Hutton's calculations, but need not be noticed here.

20. In this manner it was found that the velocities assigned to projectiles, according to the parabolic theory, are much less than the actual velocities; and that the resistance of the air, instead of being inconsiderable, is such, that projectiles which, with an initial velocity of 2,000 feet in a second, range only between two and three miles, would, in vacuo, range twenty times as far. This difference is shown in the following table, by which it appears that the ranges, instead of being as the squares of the velocities, as in the parabolic hypothesis, are in a less proportion than the velocities; and, from 800 to 1600, the most ordinary velocities with guns, the ranges are nearly as the square-roots of the velocities.

Table of the Motions of a 24-pound Shot, projected at 45° Elevation.

Velocity per second.	Range in vacuo, or according to Parabolic theory.	Actual range.
Feet.	Yards.	Yards.
200	415	320
400	1658	1000
600	3731	1391
800	6632	1687
1000	10362	1840
1200	14922	1934
1400	20310	2078
1600	26528	2206
1800	33574	2326
2000	41450	2438
2200	50155	2542
2400	59638	2640
2600	70050	2734
2800	81241	2827
3000	93262	2915
3200	106111	2995

21. In practice it also appears that the greatest range is not produced by an elevation of 45°, as in the parabolic theory, but that, according to the weight and velocity of the projectile, the amplitude may be increased by lessening the elevation even as low as 30°; small velocities and large shells ranging farthest at an elevation of nearly 45°, whilst about 30° produces the greatest range, with small shells projected with great velocities. In the first case the resistance is comparatively trifling—in

the latter it is such as is exhibited in the table. This difference, well known in practice, may be correctly exhibited to the student in the following simple manner.

22. Place a straight rod of wood A P, Fig. 4, to make an angle of 45° with the horizontal plane A Q, having a joint at A, by which the angle P A Q may be varied at pleasure. If a number of bullets be attached to threads fastened to the rod A P at the equal divisions B, C, D, E, F, &c., and the spaces, or lengths of thread from the rod to the centres of the bullets, be made proportional to the squares of the corresponding times in A P, then the curve A, 1, 2, 3, 4, 5, &c., will be a parabola (7); and if we either increase or diminish the elevation of the rod, (in the former case adding more bullets to show the effect,) we shall find that the farthest hanging bullet will not be so far from A as when the elevation was 45°. (9). Again, take another rod, jointed as before to a horizontal plane, and insert the threads at the *unequal* divisions B, C, D, E, F, &c., Fig. 5, decreasing from the effect of resistance;—the curve will not now be a parabola, because the externals B 1, C 2, D 3, E 4, F 5, &c., are not proportional to the squares of the intercepted parts of the tangent. If we now diminish the angle by lowering the

rod A P, we shall find that the range shown by the last hanging bullet, probably bullet No. 10, in the line A Q, will be greater than A H; and, according to the supposed degree of resistance by which the lengths of A B, B C, C D, &c. are diminished, we shall find the angle lessened which produces the greatest range. This scheme shows the case as correctly as the real practice.

23. To explain the nature of resistance to the flight of shot and shells, it must be remarked, that in the motion of a ball through the air, no particle of that fluid can be disturbed without moving at the same time a great many others; and not in any one direction, but according to that of their contact with those from which the impulse is received. As the moving body passes on, there is left behind it a kind of vacuum, more or less complete, according to the degree of velocity. When the ball moves quicker than the air can rush into the space left behind, the vacuum becomes complete. Now there is a certain limit to the velocity with which air can rush into a vacuum, viz. about 13 or 1400 feet in a second,* and consequently when the velo-

* 1366 when the barometer stands at thirty inches. See Hutton's Tracts, vol. iii. p. 195.

city of the ball is greater than this, it is manifest that the resistance must be much increased; for there being then no pressure of the fluid behind the ball, it will have to support the whole weight of a column of the air on its fore part, as well as to give motion to the particles which it strikes; and the air which is before it, will be in a very condensed state.

24. The effect of resistance is so various, according to the velocity, diameter, and weight of the projectile, that experiment alone can determine it. If shot could be discharged so accurately as to hit a ballistic pendulum at considerable distances, the loss of velocity occasioned by resistance, might be easily found; but such a degree of accuracy cannot be obtained, and the ballistic experiments have hitherto only furnished us with these results at different distances, as far as 300 feet; beyond which, shot cannot be directed with sufficient accuracy to hit the block.

25. The method of determining the resistance of the air by the ballistic pendulum did not, it was found, answer with velocities under 300 feet in a second, on account of the balls rebounding from the block, instead of entering into it. To ascertain the resistances to smaller velocities, Mr. Robins had recourse to experi-

ments with his *whirling machine*, Fig. 6. Plate I. This ingenious contrivance consists of a brass barrel, B C, moveable on its axis, and furnished with friction wheels so as to reduce the friction to an inconsiderable quantity. A light, hollow cone, A F G, is placed upon the barrel, with the vertex A in the termination of the axis; a fine wire, A H, supports the arm, G H, upon which the body, whose resistance is to be tried, is fixed. A silk line is wound upon the barrel, and thence leads, in a horizontal direction, to the pulley L, over which it is passed, and a proper weight M hung to its extremity. If the weight M be left at liberty, it will descend in accelerating motion, causing the body P to revolve with increasing velocity, until the resistance on the arm G H, and on the body P, become nearly equal to the weight M, when the motion of both will be nearly equable. Thus, when the machine has acquired an equable motion, which it usually does in five or six turns, ascertain first, by counting a number of turns, in what time one revolution is performed. Then remove the body P and the weight M, and find, by trials, what smaller weight will cause the arm G H to revolve in the same time as when P was fixed to it; and the difference of the two weights is, obviously, equal, in effort,

to the resistance of the air on the revolving body. Reducing this weight in the ratio of the length of the arm to the semi-diameter of the barrel, to equalize the power, we shall have the absolute quantity of resistance.

26. With this machine Mr. Robins ascertained that the resistance of the air to a 12*lb.* iron ball, moving with a velocity of 25 feet in a second, is not less than half an ounce avoirdupois; and that the resistance of the air, within certain limits, is nearly in the duplicate proportion of the velocity of the resisted body, that is, as the square of the velocity.

27. A light, hollow globe, the size of a 12*lb.* shot, was fixed at the end of the arm, and a weight of $3\frac{1}{4}$*lb.* hung at M. Ten revolutions being first made, the succeeding twenty were performed in $21\frac{1}{2}''$. The globe was then removed, and a thin plate of lead, equal in weight to the globe, placed in its room; when it was found that a weight of 1*lb.* caused the arm to move quicker than before, making twenty revolutions in $19''$, after ten turns had been suffered to elapse. Now twenty revolutions in $21\frac{1}{2}$ seconds, the radius of revolution being 51·75 inches, gives a velocity of $25\frac{1}{4}$ inches in a second; whence it is evident that the resistance on the globe is not less than the effect of $2\frac{1}{4}$*lbs.* placed

at M; and, the radius of the barrel being nearly $\frac{1}{50}$ part of the radius of the circle described by the centre of the globe, it follows, that the resistance of the globe is not less than $\frac{1}{50}$ part of $2\frac{1}{4}$*lbs.* or $\frac{1}{50}$ of 36 *oz.* which is considerably more than $\frac{1}{2}$ an ounce.

28. For the second experiment, weights in the proportion of 1, 4, 9, 16, were hung on at M; and, after ten revolutions, the following observations were made.

With $\frac{1}{2}$*lb.* at M the globe turned 20 times in $54\frac{1}{2}''$.
That is 10 times in $27\frac{1}{4}''$.
With 2*lbs.* it turned . . 20 times in $27\frac{1}{2}''$.
With $4\frac{1}{2}$*lbs.* turned . 30 times in $27\frac{1}{2}''$.
With 8*lbs.* turned . 40 times in $27\frac{1}{2}''$.

So that it appears the revolutions in the proportions 1, 2, 3, 4, correspond to resistances in the proportions 1, 4, 9, 16, which shows that the resistances are as the squares of the velocities; that is, four times as much when the body moves with twice the velocity; nine times as much when it moves with three times the velocity, and so on.

29. Doctor Hutton was fortunate enough to procure the very machine with which Mr. Robins made these trials; and a series of experiments confirmed the former deductions.—

The Doctor draws the following inferences* from his investigations.

1st. That the resistance is nearly as the surface; increasing but a very little above that proportion on the larger surfaces.

2dly. The resistance to the same surface, with different velocities in slow motions, is nearly as the square of the velocity; but gradually augmenting as the velocity increases.

3dly. The round and sharp ends of solids suffer less resistance than flat or plane ends of the same diameter.

4th. When the hinder parts of bodies are of different forms, the resistances are different, though the foreparts should be exactly alike, and equal; owing to the different pressures of the air closing on the after-parts.

30. Having described the machines that have been used to investigate experimentally all important circumstances in the principles and practice of gunnery; and having shown the methods in which these machines are applied, we shall now proceed to consider, under distinct heads, the various cases that became the subjects of trial. We shall then exhibit, shortly, the practical deductions that have been ob-

* Hutton's Tracts, vol. iii. p. 190.

tained from those experiments; and, lastly, apply these established principles to the practice of Naval Gunnery.

31. From Doctor Hutton's account of these experiments, the different cases, or questions, may be thus classed.

Case 1st. With respect to the action of charges of gunpowder, in different quantities.

2dly. To determine the velocities of shot of equal weight, discharged from the same gun, with different charges of powder.

3dly. To determine the velocities of balls of the same diameter, but of different weights or densities, discharged from the same gun with constant charges.

4thly. To determine the velocities of balls with different degrees of windage.

5thly. To determine the velocities of balls, discharged with equal charges of powder, from pieces of the same weight and calibre, but of different lengths.

6thly. To determine the effects produced by increasing the charge to the greatest the piece can sustain, the weight and length of gun being constant.

7thly. To determine the velocities of balls discharged from guns of different weights or lengths, with different charges of powder.

8thly. To determine the effects produced on the velocity of the ball, by varying the weight of gun; and by restricting or preventing the recoil, charges and shot constant.

9thly. The penetration of balls of different natures, and with various charges, into masses of timber.

10thly. To determine the effects produced by different degrees of ramming; and by using wads of different degrees of tightness.

11thly. To compare the actual ranges and times of flight, with the initial velocity obtained from the motion of the pendulum, in order to determine the effect of the resistance of the air.

CASE I.

On the Inflammation of the Charges of Gunpowder.

32. It appeared that powder inflames almost instantaneously.

Observations.—With the ordinary charges of powder this appeared to be the case; but when great charges were used, as in the experiments Case 6, the velocity of the ball became less with

any augmentation of charge beyond a certain quantity. In this case it is evident that the ball must have been driven out, before all the powder was ignited; and, consequently, that the inflammation of gunpowder, though apparently instantaneous, is nevertheless only rapidly progressive.

CASE II.

On the Velocities of Balls of the same Weight, discharged with different Charges of Powder.

33. Balls of the same weight were fired into the pendulous block with different charges of powder from the same gun. The results showed that the velocities communicated were directly as the square-roots of the charges of powder.

Observations. — The effect of cannon shot, particularly in naval actions, is always increased, more or less, by the splinters torn off the timber through which the balls penetrate.

It is, I believe, a general rule, to use the full charges of powder at the commencement of

any action, and to reduce them as the guns become heated. This is a very proper precaution to guard against accidents in continued, quick firing; but a general rule to commence action with the full charges may, in some cases, interfere with the important effect that might be produced from splinters. The prodigious ravages occasioned by splinters, in naval actions, are such, that we should study as much as possible, consistently with other views, to reap the fullest effect from so destructive an agent; and this depends very much upon the degree of velocity with which the balls penetrate.

34. In close action, shot discharged from large guns with the full quantity of powder, tear off fewer splinters, than balls fired from the same nature of guns, with reduced charges (100). This may be familiarly exemplified by firing a musket or a pistol charged with bullet, through panes of glass, at different distances, or with different charges. Superior velocity will make a clean, round hole, without breaking or even cracking the plate; but a certain reduced celerity will dash the glass to pieces.

35. In firing into masses of timber, or any solid substance, *that* velocity which can but just penetrate will occasion the greatest shake, and tear off the greatest number of, and largest,

splinters (100); for, as in the brittle glass, the parts struck by a ball moving with great celerity, are driven out before they can communicate motion to the adjacent parts of the medium; so, with inferior velocity, the corresponding shakes extend to various distances, and tear the fibres of timber, or disturb the parts of the medium, in various degrees.

The momentum, or the product of the weight into the velocity, is not, therefore, so material in this case, as the degree of velocity. This may either be regulated by reducing the charge of powder, or (case 3, art. 36,) by increasing the weight of whatever is projected. The latter is the most simple, and in close actions the most destructive. But even with two balls discharged from heavy guns, the degree of velocity communicated by a charge of $\frac{1}{3}$ the single shot's weight, is too great to produce the fullest effect from splinters: for (103) two shot discharged from a $6\frac{1}{2}$ feet 24-pounder, with a charge of 4*lb.* ($\frac{1}{6}$ the weight of the shot,) generally penetrated a mass of timber 5 feet 2 inches thick, placed 100 yards distant. In this experiment some of the balls did not perforate, on account, no doubt, of differences in the windage; but the penetration was, on an average, four feet, which is $1\frac{1}{2}$ feet more than the thickness of the side of a

74-gun ship on the lower deck. In close actions, therefore, the charges of guns, even double-shotted, might, as far as effect from splinters is contemplated, be somewhat reduced, even at the commencement of an action. But it is necessary to qualify this observation, lest it should be too generally applied. This should depend upon the nature of the gun, the distance and position of the enemy, and the steadiness or unsteadiness of the action. If no greater force were wanted than that which is capable of penetrating the side of the enemy's ship with the greatest effect from splinters, the observation just made might be very generally observed; but, whilst we keep this object in view, we should more particularly provide for the destruction of masts, dismounting of guns, and destroying their carriages; breaking beams, and penetrating masses of timbers in oblique firing. Vessels armed with the heavier natures of guns (i. e. large vessels) in close, steady, broadside-action, may certainly use reduced charges, if, as in attacking an enemy at anchor, the relative positions do not rapidly change, and the carrying away masts be not of such primary importance. Now (98, 3d head,) large balls not only make larger holes, but also penetrate farther than small balls moving with the same velocity; and as the

velocity of a shot from a 24-pounder gun, at close action, with the service charge, is more than sufficient to penetrate any mast, we are at liberty to sacrifice some of their superabundant power, by lessening the charge, for the purpose of obtaining an increased effect from splinters which may be driven off masts, spars, &c. or any other timber, as well as off the ship's sides. Nothing, however, can be spared in force, with two shot at least, with any nature of gun up to the 12-pounder inclusive; with the higher natures, charges of $\frac{1}{4}$ the weight of the shot may be used with advantage; but in no case for raking or diagonal fire.

CASE III.

To determine the Velocities of Shot of the same Diameter, but of different Weights, or Densities, the Charges being constant.

36. The experiments under this head showed that the velocities communicated by constant charges, to shot of the same diameter but of different weights, are, inversely, as the square-roots of the weights.

Observations.—To gain an increase of range or penetration, or to augment the force of the blow with which shot strike, balls made of heavier matter may be used with advantage. A shell, filled with lead, will produce a greater blow than an iron shot of the same diameter, discharged with the same quantity of powder; for, as will be shown presently, the momenta, or force of the blows, are directly in the ratio of the square-roots of the weights of shot. The former may also be made to range farther than the iron-ball, from being better able to overcome the resistance of the air; and consequently retaining longer the superior velocity communicated by a greater charge of powder. From this an increase of accuracy also results, because the same range may be produced with less elevation; and accuracy is gained as elevation is reduced.

37. Heavy, or, as I shall call them, compound shot, may be used with great advantage against vessels, such as we are told have been constructed for floating batteries, with sides so thick as to be proof against the known penetration of ordinary shot; for balls made of heavier matter (strong shells run full of lead) will penetrate farther, and be more formidable in every way. If the sides of these vessels be made of

solid masses of timber, then red-hot solid shot should be used; and if they lodge, the effect will be rendered the more certain; but as the furnaces for heating shot on board of ships cannot supply as many balls as may be discharged, cold shot must also be used. The effect of these will be more or less formidable, in proportion to their powers of penetration and their momenta, both of which will be greater with the compound heavy shot, than with solid iron balls. The weight of a 24-pounder shell, run full of lead, of the same diameter as the shot, is about 27·975*lb.*; for the weight of the shell is 16·48*lb.* and that of a solid ball of lead of the diameter of the cavity (3·767 inches) is about 11·49*lb.** Now the velocities of balls of the same diameter, but of different weights, discharged with the same quantities of powder, being inversely as the square-roots of the weights of the balls, the velocity of the shell-shot will be less than the velocity of the iron ball, in the proportion of $\sqrt{28}$ to $\sqrt{24}$. So that the velocity of a 24*lb.* iron ball, with a charge of 8*lb.* being 1339 feet per second, (109) the velocity of the shell-shot

* The weight of a 5½ inch howitzer-shell, run full of lead, is only about 26*lb.*; because it is smaller than a gun-shell, viz. as 5·25 to 5·575. This arises from pernicious complications in the system of windage, to be noticed hereafter.

of 28*lb*. weight, with the same charge, would be 1224 feet. But the velocities of balls of the same weight being directly as the square-roots of the charges (Case II.), if we increase the charge from 8*lb*. in this proportion, viz. to 9·094*lb*. or $9\frac{1}{10}$ nearly, the velocity of the shell-shot will be equal to that of the 24*lb*. ball. This is a very simple way of increasing the weight of metal as it is popularly called, and on particular occasions it may be used with considerable advantage.

38. In chasing, or in flight, heavy compound shot, fired from long guns with charges increased in the proportion just shown, will increase the power of range, and consequently the chance of carrying away a mast or a spar, at a very considerable distance.* For such special purposes as these, it may, therefore, be expedient to provide a few compound shot, with directions how to use, and injunctions to economize them. This is one of the refinements in gunnery which show the importance and necessity of some general plan of instruction in the established prin-

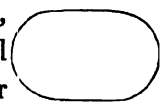
* A very distinguished naval commander mentioned to me that he knew a person who had served in an American privateer, which having been out of shot, and being unable to procure a supply of iron balls, used leaden shot, as substitutes. This person always mentioned with great surprise, the superior effect of leaden balls.

ciples, for it admits of very useful application; but, I dare say, the purely practical man would not receive it from any uninvestigated assertion.*

39. This principle also shows, as suggested by Doctor Hutton, that oblong-shot may be used occasionally, with advantage, either against ships, or in breaching batteries by land. The great uncertainty of such shot, however, from irregularities in their flight, would not, at any great distance, be compensated by the advantages contemplated; but they might sometimes be used, at moderate distances, with great effect, particularly by vessels carrying only 9 or 12-pounder *guns;* for the weight of metal may thus be increased so much as to be capable of carrying-away a mast which a round-shot could not fell: and the oblong-shot would make large irregular fractures in the side of an enemy's ship, which it would be very difficult to plug up.

* At the siege of Cadiz the French used shells filled with lead, which, discharged with a velocity of about 2000 feet per second from howitzers, (one of which is now placed as a military trophy in St. James's Park,) ranged to the astonishing distance of three miles. A 13-inch shell (British) filled with lead, and discharged at an elevation of 37° 15′, with a velocity of 2000 feet per second, would range 15726 feet, or 3 miles nearly. See article 118.

40. The windage of oblong-shot should not be greater than ·14 of an inch, (the windage of a carronade,) so that, in fact, a 12-pounder gun discharging a solid of iron of 24*lb.* weight (which its oblong-shot might be,) with a charge of 4*lb.* would be capable of producing as great an effect as a 24-pounder carronade; and if the oblong-shot were to strike with its larger dimensions, the effect would be much greater. Oblong-shot should be cylindrical, with hemispherical ends. For a 12-pounder, a shot of this shape, exactly equal to the weight of two 12-pounder balls, should be 2·935 inches long in the cylindrical part, and the total length 7·338 inches. In close action the chance of hitting with both balls is so great, that two round-shot should be preferred to this expedient; but when the distance is such, compared with the magnitude of the object fired at, that from the divergence of the balls, both cannot hit, it may frequently prove advantageous to increase the weight of metal with the smaller natures of guns, in the manner proposed.



The proposition for using oblong-shot is not new. Some very extensive experiments were made at Landguard Fort in 1776, to ascertain the comparative ranges, and accuracy, of long

and round shot, with 42, 24, 18, and 12-pounders. It is not our object to notice the trials made with the three higher natures of guns, because it is not necessary to increase the momenta of their balls for any naval service; but the experiments made with the 12-pounder are given in Table XIX. The charge was *5lb.* of powder. The weight of the long-shot was nearly double that of the ball; but the windage of the former was about ·1 of an inch less. The ranges with the oblong-shot were of course considerably less than with the balls; but it does not appear from these trials that the variations or errors in practice with the former, were greater than with round-shot, at point-blank, 1°, 2° and 3° of elevation; and as the ranges corresponding to these elevations, were, with oblong-shot, 774, 1112 and 1417 yards, we may within these limits, and on suitable occasions, safely adopt a practice which would increase the effect in a very considerable proportion. There cannot be any doubt that oblong-shot of the above shape are infinitely preferable to bar-shot. Oblong-shot would occasion great ravages in a wall or scarp, and be more likely, by the great shake they would occasion, to bring it down, after the part intended to be breached is disunited from the

adjoining parts by round-shot fired with great charges.

41. But although the practice with oblong-shot be, from their more irregular flight, less certain than with round-shot, (for which reason, together with objections to the single chances, a plurality of balls is preferable,) yet the principle upon which oblong-shot have been suggested, leads us to consider the practice of firing two or more balls from the same gun. I shall endeavour to put this in a familiar point of view, although, to the scientific reader, the popular explanation may perhaps be less satisfactory.

42. If an oblong-shot, twice the weight of a round-shot of the same diameter, be fired with the same charge, the velocity of the former will be less than the velocity of the latter, in proportion as the square root of the weight is greater. That is, the weights being as 1 to 2, the velocities will be as $\sqrt{2}$ to 1, or as 1·4142 to 1. But, although the velocity be decreased, the force of the stroke will be increased, in the ratio of the square-roots of the weights; for the momentum (the weight multiplied by the velocity) of the oblong-shot will be $2 \sqrt{1}$, and that of the round-shot as $1 \sqrt{2}$, which are to each other as 2 to 1·414, or as 1·414 to 1, the square-roots of the weights. So that by using the

oblong-shot, (40) from a 12-pounder, instead of its round-shot, the momentum would be increased as $\sqrt{12}$ to $\sqrt{24}$ or as 3·464 to 4·898.

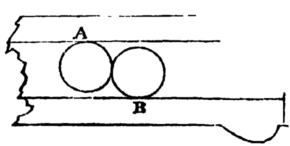
Now whether the double weight be in one oblong-shot, or in two single balls, the velocity of each will be decreased in the same ratio, or as $\sqrt{2}$ to 1. If there be three balls, or one mass of the weight of the three, the velocity will be decreased as $\sqrt{3}$ to 1: if 4 balls, as $\sqrt{4}$ to 1, or as 2 to 1, and so on. The velocity of a 24*lb.* shot, with a charge of 8*lb.* is 1339 feet per second of time (109.) With two balls, and the same charge, the velocity will be reduced as $\sqrt{2}$ to 1, or as 1339 to 954. The velocity of each ball, therefore, is the same as that of a shot discharged, singly, with a velocity of 954 feet in a second, that is, with half the former charge; for the velocities are as the square-roots of the charges; and 1339 is to 954, as 2·8284 (the square-root of the charge 8*lb.*), to 2 the square-root of 4. Now the point blank range of a 24-pounder gun, with a charge of 4*lb.* is very much less than with the full quantity of powder; and with this reduced charge, or with two shot and the full charge, the elevation must be nearly double that which, with one shot and the full charge, produces the same range. Thus with one shot, the ranges with 8*lb.* at 1° and with

4*lb.* at 2°, are nearly alike.—With two shot and the same charges, the elevations required to produce the same ranges would be about 1¾° and 3½°. In using two shot, therefore, there is commensurate loss of accuracy, not only from the divergence of the balls, but from their requiring greater elevation, which should deter us from adopting this practice, excepting at close quarters, when it is scarcely possible to miss; and never with carronades after one breeching (for they should always have two) is broken; nor, as in fighting the weather-side, when the inclination is much in the direction of the recoil.

43. In practice with two shot there are besides some causes of irregularity, which it is proper here to point out, that will further show how little it can be depended upon, excepting in close action. Two shot discharged from the same gun do not range alike. It appears, Table IX., that, in this practice, there is frequently a difference of range of about a hundred yards. Now besides this difference of range, there is also a horizontal divergence, which, in firing at ships at long ranges, or at any objects whose magnitudes are not sufficient to subtend the divergence of the balls, incurs a considerable risk of missing entirely, and a certainty of not hitting with both. If the balls touch each other

on quitting the gun, which very frequently happens, some deviation must arise, according to the nature of the collision. If it be direct, one ball will be accelerated, and the other retarded, by the blow. But this will rarely happen—it is more likely that the blow will be oblique; from which both balls will diverge, very considerably, in directions compounded of the projectile velocity, and the force and direction of the collision.

44. In firing two shot, another cause of deviation, still more destructive of accuracy, is operating during the passage of the balls along the bore; particularly when the windage is great. The shot nearest to the charge impelling the other, will evidently be forced to one side of the cylinder, as at A, pressing the outward ball to the other side of the bore B. From this



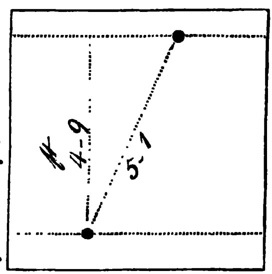
it is manifest, that the outward ball B must receive an oblique impetus on its departure from the muzzle, which will disturb, from reaction, the direction of the other. This deviating cause may either operate in a lateral, or in a vertical direction: in the former case it will affect the line, in the latter case the elevation of the shot's departure, and consequently the

length of range; * or the error may partake of both.

Hence it appears, that using a plurality of

* The following experiments show how much inaccuracy is increased by excessive windage, in practice with two shot.

A 24-pounder loaded with 6*lb.* of powder and two high shot, (a term to express small windage), was discharged at a target 6 feet square, 100 yards distant. The average spread of the balls was about 1 foot 3 inches. Two 18*lb.* shot were then fired from the same gun, with the same charge. The windage in this case was about ·7 of an inch. The distance between the centres of the perforations in the target was 5 feet 1 inch; and their difference of level was 4 feet 9 inches. Making the distance of the target (100 yards) radius, 4 feet 9 inches, (the difference of level) is the tangent of 55′, the elevation of the direction of the upper ball above the other; so that besides the spread of the balls, there was a difference of range, corresponding to a difference of elevation of about a degree in the shot's departure.



The windage here used is an extreme case; but the corresponding magnitude of error shows plainly that great windage is productive of great uncertainty, from the causes I have pointed out, in practice with two shot. The regulated windage for a 24-pounder gun is ·27 of an inch; but I have frequently seen shot so reduced in size by the long action of destructive agents, as to increase the windage to an almost incredible degree.

balls is productive of so much uncertainty, that, with great windage particularly, the practice should only be adopted when the contending ships are pretty close, when it may be used with effect, because the mark is then too large to be easily missed; and the decrease of velocity is favourable to the effect from splinters.

CASE IV.

To determine the Velocities of Balls with different degrees of Windage.

45. Windage is the difference between the diameter of the shot, and the calibre of the gun.

The following Table shows the Windage of Guns and Carronades, in Decimals of an Inch.

Natures.	Prs. 68	Prs. 42	Prs. 32	Prs. 24	Prs. 18	Prs. 12	Prs. 9	Prs. 6	Prs. 4	Prs. 3	Prs. 2	Prs. 1
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Guns -		·33	·30	·27	·25	·22	·20	·17	·15	·14	·12	·09
Carronades	·15	·15	·15	·14	·12	·12						

From experiments made on this important question it appeared that very great differences in the velocities of balls arise from very small

differences in the windage:—that with the degree of windage established in our service, no less than between $\frac{1}{3}$ and $\frac{1}{4}$ of the force of the powder escapes and is lost; and that as balls are often less than the regulated size, it frequently happens, that half the force of the powder is lost by unnecessary windage!

Observations. This being established, there can be no doubt of the vast advantages that would attend a diminution in the quantum of windage.

46. The present degree of windage may have been necessary when guns were imperfectly bored, and shot incorrectly cast: but proofs of the accuracy of both are now so rigid, that no allowance need be made for any errors of construction.

47. The prejudicial effect which the present windage has upon accuracy, arises from the reflections of the ball in passing along the bore. These will manifestly be greater in proportion as the difference between the diameter of the shot and the calibre of the gun increases. From these reflections, shot acquire a sort of zig-zag motion, and do not generally quit the cylinder in the direction of its axis. If the last bound be upon the lower part of the bore, the angle of the shot's departure will be increased—if above,

diminished—these affect the length of range. If the last reflection be on either side of the bore, the line will be altered; and, in every case, the friction arising from these rubs will give the ball an irregular, whirling motion, productive of great inequality of resistance from the air, unless the rotation be at right angles to the direction of the projectile's flight.

48. It is well known that the diameter of the shot is the datum from which the quantity of windage and the calibre of the gun were originally determined. Thus the diameter of the shot was supposed to be divided into 20 parts—one of these was allowed for windage, and the calibre of the gun made equal to the sum of both. In this manner the diameter of a 24*lb.* shot being 5·547, $\frac{1}{20}$ of it, or ·277, was allowed for windage, and $5{\cdot}547 + {\cdot}277 = 5{\cdot}824$ the calibre of the gun.

This degree of windage was exclusively observed, till the proprietors of the Carron Company, availing themselves of the discoveries made in the ballistic experiments in favour of reduced windage, determined to apply the principle in the construction of their carronades; but as no alteration was made in the windage for guns, (which should have been done, by in-

increasing the diameter of the shot,) the Carron Company lessened the calibres of their new ordnance, to admit ordinary shot with reduced windage—so that carronades being now completely adopted in the King's service, a most extraordinary anomaly is recognised by admitting the correction, and at the same time retaining the error. From this extraordinary circumstance great confusion and complications have arisen in the windage of shells also. Those for guns are of the same diameter as their shot; but carronade shells are smaller by about ·1 of an inch. Now surely if carronades admit ordinary shot, there can be no reason why their shells should be smaller;—that is, there can be no reason why the windage should be greater for a shell, than for a shot. This indeed is practically admitted by the windage allowed for mortars and howitzers, which is only ·15 of an inch for all natures, excepting the $4\frac{2}{5}$, which is 2! Surely these inconsistencies should be remedied as soon as possible.

49. Any alteration in the regulated windage should evidently be made by casting new shot, and not by making new guns; it follows, therefore, that if windage is at all to vary according to the nature of the gun, the expression should

be taken from its calibre, and not from the diameter of the ball. Thus, instead of expressing the windage $\frac{1}{20}$ (or whatever it may be altered to,) of the diameter of the shot, it is much more simple, and more natural, to change the denomination to $\frac{1}{21}$ of the calibre of the gun, and to express the diameter of the shot $\frac{20}{21}$, thus adopting the calibre of the gun as the standard. But why should the windage be so regulated at all? The proofs to which the bores of guns and the shape of shot are now submitted, authorize us to rely upon the former being perfectly cylindrical, and the latter correctly spherical; and consequently that no allowance need be made for any degree of inaccuracy. What then are the considerations which should be provided for, in determining the degree of windage? 1stly. The expansion of shot by a white heat. 2dly. The incrustation of a little rust. 3dly. The foulness of the cylinder in continued firing; and 4thly, the thickness of the tin straps for wooden bottoms. I know no other data that should be taken into consideration, and these do not require that the shot should bear a certain fixed proportion to the diameter of the gun, but merely that a sufficient allowance be made to ensure the admission of the shot under all these circumstances.

50. The degree of expansion of shot by white heat is expressed in the French tables, as annexed. This is about $\frac{1}{70}$ of the diameter of the shot for the 24-pounder; $\frac{1}{76}$ for the 16; and $\frac{1}{82}$ for the 6-pounder.

Expansion by white heat.		Nature of Shot.
lines.	parts	Prs.
"	11	24
"	9	16

51. The French allow 1 line 6 parts for the windage of heavy or siege ordnance, and 1 line for field ordnance. The former, reduced to English measure, is ·133 of an inch, and the latter about ·088, which are not much more than $\frac{1}{3}$ of ours.

The calibre of a French 24-pounder is *5in. 7l. 7½p.* One line six parts for windage is 18*p.* which is about $\frac{1}{45}$ of the calibre of the gun.

The calibre of a French 8-pounder is 3*in.* 11*l.* or forty-seven lines; and one line for windage is $\frac{1}{47}$ of the calibre of the gun.

52. If then the windage must be proportioned to the shot or gun, I recommend, with confidence, that it be decreased to $\frac{1}{40}$, or at most to $\frac{1}{35}$ of the calibre. These degrees of windage, and the corresponding diameters of balls, are shown in the following table; in the seventh column of which the present degree of windage is inserted, to show the differences.

TABLE I.

Nature of gun.	Calibre of gun.	Windage $\frac{1}{35}$ of calibre.	Diam. of shot $\frac{34}{35}$ of calibre.	Windage $\frac{1}{40}$ of calibre.	Diam. of shot $\frac{39}{40}$ of calibre.	Present windage $\frac{1}{20}$ of shot's diameter.
Prs.	in.	in.	in.	in.	in.	in.
42	7·018	·2	6·818	·175	6·843	·33
32	6·41	·183	6·227	·16	6·250	·30
24	5·823	·166	5·657	·145	5·678	·27
18	5·292	·151	5·141	·132	5·16	·25
12	4·623	·132	4·491	·115	4·508	·22
9	4·200	·12	4·08	·105	4·095	·20
6	3·668	·105	3·563	·092	3·576	·17
4	3·204	·092	3·112	·08	3·124	·15
3	3·013	·086	2·927	·075	2·938	·14
1	2·019	·058	1·961	·05	1·969	·09

53. But I repeat, why should the difference between the diameters of the ball and cylinder, which may be necessary to permit the shot to enter freely under the different circumstances of heat, rust, foulness, and tin straps—why should it vary with different cylinders? These circumstances bear no relation to the magnitude of the cylinder or ball, excepting the expansion of the latter by heat; and that in the largest balls is only, on an average, $\frac{1}{70}$ of the calibre, or $\frac{1}{2}$ of the proposed windage $\frac{1}{35}$. The windage of carronades recognises this reasoning; for it is fixed at ·15 of an inch for the three higher natures, viz. for 68, 42, and 32-pounders; ·14 is allowed for 24 pounders; ·12 for 18 and

12-pounders; and ·15 is the allowance for the windage of all the higher natures of mortars and howitzers.

54. Suppose the windage of a 24-pounder carronade (·14 of an inch) were adopted for all the higher natures of ordnance; this in the 24-pounders would be $\frac{1}{43}$ of the calibre; but the French allowance (which, as we have seen, does not vary with the nature of the gun) is only $\frac{1}{45}$ of the calibre in the 24-pounders. Now no degree of foulness from quick firing, and no coating of rust that should be suffered to remain, or can well remain on a shot, is equal to ·07 (about $\frac{1}{15}$) of an inch, which a windage of ·14 would allow. If, therefore, we adopt ·14 for the windage of heavy guns, we proceed upon a certainty in the improvement; but, perhaps, ·13 of an inch is windage sufficient for all natures of guns and carronades, from the 68-pounder carronade to the 12-pounder inclusive—and downwards from the 9-pounder gun inclusive, I recommend ·1 or ·11. The proportions which these degrees of windage bear to the calibre of the gun are shown in the following Table.

TABLE II.

Nature of ordnance.	Calibre of ordnance.	Proposed windage.	Proportion of proposed windage to calibre of gun.
Prs.	in.	in.	About
42	7·018	·13	$\frac{1}{53}$
32	6·41	·13	$\frac{1}{49}$
24	5·823	·13	$\frac{1}{44}$
18	5·292	·13	$\frac{1}{40}$
12	4·623	·13	$\frac{1}{35}$
9	4·2	·1	$\frac{1}{42}$
6	3·668	·1	$\frac{1}{36}$
4	3·204	·1	$\frac{1}{32}$
3	3·013	·1	$\frac{1}{30}$
1	2·019	·1	$\frac{1}{20}$

55. This important reform would admit of a considerable saving of powder; for those velocities which at present require charges of $\frac{1}{3}$ the weight of the shot, might be produced with smaller quantities of powder. We should also have greater accuracy in practice, and, consequently, greater effect; but a series of experiments should be made, before this scale is altered, to ascertain whether shot of the proposed magnitude will roll freely home; repeating these trials with a great many new shot, and in a great many guns. Also to make trials of the new shot heated to white heat, and with cold shot under the various circumstances

of foulness from quick firing, and the incrustations of rust.

56. But whether a new scale of windage be adopted or not, it is important that shot be protected as much as possible from those vicissitudes, and from that treatment, which are continually operating to diminish their size, and consequently to increase the windage. Every possible precaution, therefore, should be used to keep shot from rust, by painting or greasing them, and to keep them as dry as possible—perhaps some better way of storing them might be found, than throwing them promiscuously into the shot lockers. When shot are cleaned, the rust should be carefully rubbed off, and not *beaten* off with hammers. This mode of cleaning shot, as practised in the arsenals, should be strictly prohibited; and also the more destructive method of putting a number of rusty balls into a rotatory machine, in which they are literally ground to very reduced magnitudes, and the windage prodigiously increased. It is useless to talk of the effects produced by a minute regulation of windage, so long as such practices continue. These precautions should be strictly observed; for, if the degree of windage demand rigid and nice restriction, it is no less important to secure it from increasing; and this can only

be done by carefully protecting the shot from all destructive agents and operations. Shot gauges should be issued to all vessels of war, and the shot frequently overhauled and gauged. These proofs should invariably be made of shot returned from paid-off vessels, and none but standard shot should be re-issued.

57. Some very important consequences have resulted from the observations and suggestions contained in the preceding articles; but the extensive existence of the great original cause of error, and the great difficulty of getting rid of it, have wrapped the case altogether in such perplexity, that it has not been found easy to proceed in a general correction of this most defective system. It is, therefore, a matter of great importance to consider, further, what means can be devised to extricate an acknowledged improvement from those embarrassments and impediments that have been suffered to entangle and retard its advancement. The preceding remarks on windage having been brought under the consideration of the Master General of the Ordnance in 1817, his Lordship referred the paper to the consideration of a select committee of artillery officers, who stated, in their Report, "that they were very desirous that experiments should be made with a view to ascertain to what extent the benefits which" I

" had anticipated, could be realized." The committee, therefore, proposed to the Master General to be permitted to make a course of experiments on this subject, commencing with field artillery, and for that purpose recommended that a proportion of shot of various increased magnitudes should be provided. These measures having been approved, a course of experiments was instituted accordingly, " founded upon the suggestions communicated by" me.

58. Having first adopted an opinion, asserted in my observations, articles 49, 53, that the present mode of apportioning a part of the calibre is not so distinct and advantageous, as a fixed quantum expressed in parts of inches for all natures, the committee proceeded to determine what that quantum should be.

59. After repeated trials with a 6-pounder, a 9-pounder, and a 12-pounder, at 300, 600, and 1200 yards, it was proved, " that, with charges of powder $\frac{1}{6}$ less than usual, the larger shot, and smaller windage, produced rather the longest range."

" Recourse was also had to the ballistic pendulum, to discover the proportional excess of momentum of the larger balls over the smaller; and the result, after a very satisfactory course of experiments, assisted by the scientific research

and well-known mathematical abilities of Dr. Gregory of the Royal Military Academy, corroborated the trials by ranges, leaving no doubt of their accuracy."

In consequence of these trials, the Committee fixed the quantity of windage for field guns at one-tenth of an inch; the same which I had suggested. (Table II. art. 54.)

60. Now it is clear that this improvement may either be applied to save $\frac{1}{6}$ part of the quantity of powder provided for field-service, without diminishing the power of range; and consequently to economize, without detriment, the means of transport for ammunition; or the alteration may be applied to produce longer ranges, if this be preferred to the economical consideration. This preference has, very properly, been given; and the established charges adhered to accordingly.

61. A great collateral advantage has followed from this correction of windage. It was at first apprehended that the increased effects arising from the additional weight of shot, and diminished windage, would injure brass guns; but it is quite the reverse. With the reduced quantum of windage, guns are much less injured, and will last much longer than formerly; and this has been so well ascertained, that, in con-

sequence of this correction, it is now proposed to abandon the wooden bottoms to which shot were fixed for the purpose of saving the cylinder; substituting for them the paper cap taken off the end of the cartridge. This being put over the ball, is quite sufficient to keep it from rolling or shifting; whilst, by supporting or fixing it thus, the centre of the ball coincides with the axis of the cylinder, and the space for windage is reduced to a complete annulus, which admits of the percussion from the charge being equally received; and which prevents, or very much reduces, that injury, or indentation, which the cylinder receives when the ball touches it on the lower part only; for when the space for windage is all above, the action of the powder is exerted in a manner to produce that effect on the bore, near the seat of the ball, which is soon discovered in brass guns. This expedient is not entitled to considerations of a preservative nature with iron guns, because they are not so susceptible of the injury which may thus be prevented; but for accuracy of fire it will not fail to be productive of a good effect, if the expedient of putting the paper cap over the ball be used in Naval Gunnery also.

62. Experiments were also made for the purpose of ascertaining what advantage would arise

from diminishing the windage of heavy iron ordnance, in the manner I had proposed.

For this purpose, larger shot, having various degrees of diminished windage, were fired from an iron 24-pounder, ship or garrison gun, with the service charge, and with reduced quantities of powder; when it appeared so advantageous that the benefits arising from a reduced rate of windage should also be extended to the higher natures of guns, that the Committee recommended a diminution of windage to ·15 of an inch for all natures of siege and garrison guns, from the 12-pounder upwards.

63. The importance of this measure is perhaps sufficiently established by this decision; but as it is moreover necessary, in cultivating improvements in practical science, to consult the experience of actual service as much as possible, and to state any strong facts that may have occurred to guide and support us in such pursuits, it is important to exhibit here the opinion given by a very gallant and highly distinguished artillery officer* in a letter on this subject; and to show upon what solid grounds that opinion was formed.

* Lieutenant-Colonel Sir Alexander Dickson, K.C.B. who commanded the battering-train at all the sieges in the Peninsula.

"Most fully," says this officer, "do I subscribe to your proposal for diminishing the windage of our ordnance, by casting shot of a larger size than the present. Experiments are certainly necessary to ascertain how small this windage may be made, with safety; but the regulation on this head, as practised by the French, affords an excellent scale to follow, and the rates you propose, of ·13 inch for heavy ordnance and ·1 inch for light ordnance, would, I am convinced, answer perfectly well, and be conducive to future accuracy.

"I remember a very convincing proof of the advantage of high shot, which I think is worth mentioning.

"The battering-train was assembled at Almeida previous to the siege of Ciudad Rodrigo, and there being a great deficiency of transport to bring forward the shot from the rear, it became a very important object to collect as many as possible from the shot belonging to the fortress, of which there was a considerable quantity, and of an infinity of calibres. In order, therefore, to obtain every shot that would answer, gauges of the full diameter of our 24-pounder bore were used, and every shot was selected as serviceable that passed through these gauges; so that many of the highest balls chosen would not, when

heated, go into the gun; and this I ascertained by trial. When this operation had been completed, the selected shot were again tried with a gauge rather smaller than the ordinary 24-pounder shot gauge, and all that went through it were rejected as too small. The number of very high shot, however, amounted to two or three thousand; and as I know they were brought forward in the latter part of the siege, it has always been to the use of these shot that I have attributed the singular correctness of the fire in making the smaller breach; for although the battery was from 500 to 600 yards distant from its object, every shot seemed to tell on the same part of the wall as the preceding one. Now this was not the case in firing with common shot at such a distance; for some struck the wall high and others low, although the pointing, as the best gunners have assured me, was carefully the same."

64. As an artillery question, there can be no doubt of the advantages, in accuracy of practice, and either in economy of powder or in increase of effect, that would result from extending this improvement to naval guns: but here we are met by a very formidable obstacle, which, so long as it is permitted to exist, will, it may be feared, not only prevent these benefits from

being adopted in the naval service, but actually enforce the abandonment of what has been proved to be a great improvement in land-service artillery. This obstacle arises from having adopted a nature of ordnance (carronades) of smaller calibre than guns of the same nature. By this we have recognised the advantages resulting from a diminished rate of windage, (for it is upon this principle that the carronades have answered so well,) but have adopted it in a partial shape which has produced the most complicated difficulty; and which is, in truth, a disgrace as well as a detriment to the service; and this great error, from the extent to which it has been multiplied by the manufacture of vast numbers of carronades, has now put it out of our power to generalize, without incurring great expense, the very principle upon which they have proved their efficiency.

65. Thus the naval objection that has been made to the new scale of windage for sea-service ordnance, arises from the circumstance of shot, enlarged by rust, being frequently found inadmissible to carronades, though fitting guns of the same nature. But this serious circumstance does not altogether arise from enlargement by rust, or at least it should not be permitted to do so; for an accumulation of rust so consider-

able as to render inadmissible to carronades shot not originally above gauge for that nature of ordnance, can never happen with proper care; and never should be discovered with impunity; for instead of employing men in polishing and repolishing stancheons, and bolts, and bars, by way of occupying idlers, and punishing crime, the people should be set to rub, and grease, and paint shot. It is not, therefore, by the enlargement of shot from incrustations of rust, that we should be obstructed; for that may certainly be prevented: but there is an obstacle, inherent and abundant in the present system, which no degree of care can altogether obviate—it is as follows. The advantages attending a reduction of windage having long been known, and recognised in the service, it is not surprising that some relaxation should have been permitted in the dimensions of shot gauges, to diminish, a little, the windage of guns; and that shot should have been received in the arsenals, and circulated in the service, considerably above gauge for carronades. This indeed is admitted; for the Select Committee state, "that partial reductions of windage have already been made." Now no partial reduction of windage can be made, without making shot too large for carronades of the same nature. We know indeed

that shot considerably above carronade-gauge have been provided and circulated in the service; and it is a fact well known to naval officers, that ships have been sent to sea, stored with new and perfectly clean shot, which were afterwards found inadmissible to their carronades. It is not, therefore, from the incrustations of rust alone, but from the complicated defects of the system, and the "partial reductions" that have been made, that this most serious circumstance has arisen.

66. What has lately been done in new regulating the system of windage for field and garrison ordnance, is a great step towards a general and full correction of all these defects and errors. The report of the Select Committee on my suggestions, has brought the matter to a stage in which it is impossible that it should rest. It must either proceed or retrograde. If it rest where it is, the case will stand thus. Land-service shot of magnitudes corresponding to the windage ·15 of an inch, (the quantity fixed by the Committee for siege and garrison ordnance,) cannot be issued to the navy, because they cannot be used with carronades; and as this species of ordnance is frequently used in land batteries also, we must have two sorts of shot for land-service. What may we not apprehend, when

foreign garrisons are supplied with shot which carronade-armed vessels cannot use, and which ships of mixt armament cannot receive without incurring the most serious consequences that can be contemplated? It will be replied that, in such a case, care would be taken to provide sufficient naval ordnance-stores at all places of refit; that the stores for the different services would always be kept separate; and that the new land-service shot would never be suffered to circulate in the navy. But what an intricate dilemma would such a measure saddle upon original error! Such restrictive precautions may be asserted, but they cannot be observed. Ships must, under the various exigencies of distant and combined service, be supplied occasionally from land-stores; and no care, no regulation or arrangement can prevent the new land-service shot from circulating in the naval service. Naval officers, indeed, who know their business, will not—should not fail to provide themselves, whenever they can, with the most efficient shot for their guns, although they cannot use them with their carronades. Officers who, aware of the advantages of high-shot, may be able to procure them from land-stores, would perhaps take care that they be kept distinct from carronade shot; but how is the imperceptible

difference of size to be discerned in the heat of action? The command of the vessel may pass into other hands—she may be stranded, or laid up, and her stores transferred to another ship. In short, naval officers must know that it will be utterly impossible to prevent the mixture of shot, in the close connection and mutual aids which are indispensable to the success of combined service.

67. It is absolutely necessary, therefore, that the windage of the two services, be it what it may, should correspond; and, consequently, that if the advantages resulting from reduced windage cannot be extended generally to naval ordnance, the system already arranged for land-service must be entirely abandoned. This, therefore, is not a naval question: it is, in principle, a general measure of the greatest importance; and one which should not be permitted to retrograde, or to be defeated, on account of any obstacles that are not absolutely insurmountable. To proceed in the important measure which has been commenced, there may be several expedients, but there is only one perfect remedy; for so long as carronades of smaller calibre than guns of corresponding natures exist, we never can get rid of the difficulty. The only perfect remedy, then, (and peace is the only proper time

for effecting it,) is to re-bore, or *ream-out*,* all existing carronades to equality with the calibres of guns; to introduce one uniform system of windage for all natures of ordnance; and consequently to have but one gradation of shot.

68. The differences between the calibres of guns and carronades of corresponding natures are shown in the following Table.

Nature of Ordnance.	Gun.	Carronade.	Difference of their Calibres.
	Calibre. in.	Calibre. in.	in.
42-pr.	7·018	6·84	·178
32-pr.	6·41	6·25	·16
24-pr.	5·823	5·68	·143
18-pr.	5·292	5·16	·132
12-pr.	4·623	4·52	·103

69. To equalize the calibres of guns and carronades, therefore, the thickness of metal of the latter would only be reduced by half the differences in the last column of the preceding table, or about ·07, or ·08 of an inch. This trifling reduction of metal in the chase only might certainly be made, without incurring any greater risk of bursting than at present: for it is a fact pretty well known, that although numerous accidents have occurred in action from

* A term for scraping out.

the bursting of guns, yet carronades, even double shotted, have never been known to fail; they break their breechings, draw their bolts, split their slides, but do not burst; and this power of resisting their charges may be established by referring to the original proof returns. The weight of metal required to be taken out to enlarge the calibres of carronades to equality with guns of the same natures is shown in the following Table.

Nature of Ordnance.	Weight of Carronade.			Weight of metal required to be taken out from Carronades.	
	cwt.	qrs.	lbs.	lbs.	
42-pr.	22	1	0	26·2	or about 1*lb.* per cwt.
32-pr.	17	0	14	17·1	
24-pr.	13	0	0	12·8	
18-pr.	9	0	0	9·7	
12-pr.	5	3	10	5·2	

70. So trifling a diminution of weight, though certainly not in itself desirable, should not be objected to defeat the proposed measure, considering the importance of the end in view. Our arsenals being well stored with vast numbers of carronades, which it would be ruinous to condemn, and expensive to replace, a general correction of windage depends very much upon the feasibility of enlarging the calibres of existing

carronades, without danger, serious disadvantage, or great expense. Now in addition to what has been said respecting the power which carronades possess of resisting their charges, the following facts are extremely favourable to this measure. 1st. It has been found that the calibres of great numbers of carronades have become so enlarged by rust and wear, that in many cases they would only require to be reamed out. 2dly. To enlarge new carronades by boring, it would not be necessary to transport them to the boring-houses; for machines might easily be devised to re-bore them without removing them from the skids upon which they are now ranged, whether in home or foreign arsenals. 3dly. The calculated reduction of weight, expressed in the last table, has been proved, by boring up new carronades, and carefully collecting and accurately weighing the metal removed. 4thly. To these very favourable circumstances we have to add a very important improvement, (suggested by an artillery officer of well known distinction,*) which might at the same time, and by the same operation, be made in the chambers of carronades, which are at present of the shape shown by the dotted lines in the figures of Plate II. By

* Colonel Millar.

altering these into a conical form, (the Gomer principle) connecting the enlarged cylinder with the bottom of the chamber by a conical frustum, a great improvement would be effected; for the ball, pressed home with a wad, would, in that case, be fixed in the entrance of the conical chamber, and touching it in every point, leave no partial space for any unfair action of the charge upon the ball. This is a very important consideration in all cases, but particularly in using shot worn beneath gauge, by rust; for with chambers of the present shape, the smaller the balls, the more unfairly are they acted upon, from the windage being all above, and consequently from the centre of the ball being below the axis of the chamber. This alteration would therefore bestow upon the carronade, all that advantage which the Gomer principle derives from the genius of the person by whose name it is thus distinguished.

Plate II. shows the actual magnitude of the cylinders and chambers of carronades; and the proposed enlargements and alterations. The dotted lines show the present magnitudes; the black lines the corrected shapes.

71. With respect to what quantum of windage may be considered proper for all natures of iron ordnance from the 12-pounder upwards,

whenever the measure of enlarging carronades may be carried into effect, (and which must and will be done sooner or later,) there cannot be any doubt that ·15 of an inch, as already voted for siege and garrison ordnance, would be quite sufficient. Consulting experience on this head, we know, that ·14 of an inch is the quantum regulated for the 24-pounder carronades. We are equally certain that this allowance has been very rigidly observed; for any departure from it would be an abandonment of the principle which renders carronades so efficient, with such small charges. We know also (51) that the windage of all French iron ordnance, reduced to English measure, is only ·133 of an inch; and I believe the American windage rather copies the French practice than ours.

72. It has been apprehended that any diminution in the windage of naval guns would occasion more frequent accidents from bursting than at present. This opinion is founded upon the fact, that the action of the charge is increased by its taking place in more confined space than when the windage is greater. To this it is only necesary to reply, that the danger cannot be greater than at present, if the economical tendency of the measure, as fully admitted

in this objection, be taken advantage of as it ought to be; for satisfied, as appears from what has been said, that the velocities of shot according to our present practice, are quite sufficient, (rather indeed too great than too little), and knowing that the increased action of the same charge when inflamed in more confined space, would communicate greater velocity than with the present windage, we should, in reducing it, diminish also the charges, to such quantities as should be proved by experiment to be capable of maintaining the practice given in our present tables, and put the savings of powder in the pockets of the public. In this way, guns would not be more liable to burst than with the present system, if shot be carefully proved.

73. The preceding observation introduces an important remark on the modes of *gauging shot*. With ring-gauges, shot not perfectly spherical may pass in one direction, or section, but not in all; and may therefore jam in rolling into the cylinder of the gun. Shot-gauges should therefore be cylindrical, as in the French service; for balls which roll freely through gauge-tubes, cannot possibly jam in the cylinder of the piece, if it be perfect.

74. What has been said on the subject of windage shows that very minute differences in the magnitude of the shot (that is, in the quantity of windage) produce very great differences in the practice. It follows, therefore, that to preserve shot as much as possible in their primitive magnitude and condition, is no less important, than the nice and very minute investigations from which the proper dimensions of balls have now been determined; and consequently that it is of vast importance to protect shot on board of ships from the destructive effects of rust. The ease, and trim, and sailing of vessels, do not admit of their shot being stowed, in large quantities, any where above the water-line, or near the extremes. The great store of shot, therefore, must be in the lockers, where they are at present kept; and *there* it is impossible to prevent their becoming, in some degree, corroded by rust: but a sufficient number of balls, for at least fifteen double-shotted rounds, should always be kept on deck. Now these balls being the first for use, should be preserved from rust as effectually as possible, and cleaned with every degree of care. Shot from the lockers should not be used till the deck shot shall have been expended, and the uppermost balls

in the lockers should be frequently examined, cleaned from rust, and greased or painted.

But the decks of frigates and small vessels are so frequently wet with salt water, that it would be extremely difficult, perhaps quite impossible, in many cases, to preserve shot, stowed as at present, in that clean and perfect condition which is so essential to accuracy of practice. This, however, it appears to me, might be easily effected, by keeping the shot in water-tight metal pipes, wooden spouts, or timber troughs, lined with copper, (as shown in Fig. 1. Plate III.) placed in gentle inclinations, and in sufficient numbers, on the edges of the hatchways, or across them, or in any other convenient situations upon the decks. The balls, being put in at the higher end of the cases, would roll downwards in succession to their proper places, retained by the first shot pressing upon the end of the open part of the tube or spout. Whenever the lower ball is taken out, the rest would move forward; and in overhauling them for cleaning, might be replaced in succession. The tops of the shot-tubes, or cases, should be kept closed with plugs, and tompions should also be placed in the lower opening, to keep covered the ball first for use. This expedient, together with

frequent inspections, would effectually prevent enlargement by rust. This would contribute much to accuracy of practice; for considering the prodigious resistance of the air upon the surface of a cannon ball, moving with the usual service celerity, it is evident that the most minute protrusion or inequality on that surface must occasion a very irregular whirling motion, and consequently a great deviation from the intended direction. The rifle principle is a contrivance to reduce the errors arising from the unequal action of resistance on any superficial inequalities in the ball, by giving it a rapid rotation perpendicular to the axis of projection; but it is found that a ball of uniform consistency or solidity, smooth and perfectly spherical in its shape, may be projected from a plain barrel, with as much accuracy as from a rifle. Numerous very delicate experiments with musket-barrels show that accuracy depends very essentially upon the ball being smooth and perfectly spherical; and this being the case with respect to the most minute inequalities on small bodies, it may easily be imagined what must be the effect of large and rough protrusions of thick coats of rust, upon the surface of a cannon ball whose velocity is resisted by such vast force. Independently, therefore, of any consideration

relating to windage, it is of great importance to keep shot as clean and as smooth as possible.

CASE V.

To determine the Velocities of Balls discharged with equal Charges of Powder, from Pieces of the same Weight and Calibre, but of different Lengths.

75. It appeared, that with equal charges, and guns of equal weight, but of different lengths, the velocity of the shot increases with the length of the gun, but in a small proportion only.

CASE VI.

To determine the Effects produced by increasing the Charge to the greatest the Piece can sustain, the Weight and Length of the Gun constant.

76. It was found that the velocity of the ball increases with the charge, to a certain

point peculiar to each gun; and that, by further increasing the charge, the velocity gradually diminishes, till the bore is quite full of powder; yet the recoil is always increased by an increase of charge, because the ball escapes before all the powder is inflamed, which, therefore, acts latterly upon the gun only.

CASE VII.

To determine the Velocities of Balls discharged from Guns of different Weights or Lengths with different Charges of Powder.

77. It appeared that the velocities of balls, fired with equal charges, increase, as the gun is longer, in a proportion which is nearly the middle ratio between the square and cube roots of the length of the bore.

Considerations of the greatest importance arise out of this article; it leads us to analyze the comparative powers and merits of long and short guns.

78. The great partiality in favour of short

guns for naval service has had its origin in a misapplication of some of Mr. Robins's maxims and observations. That distinguished civilian, by whom the theory of gunnery has certainly been much improved, having had no practical knowledge of artillery service, (as he observes in the preface to his "Proposal to Lord Anson," printed in 1747,) it is not surprising that the maxims which he deduced from his own investigations, should frequently be regardless of that accuracy and practical efficacy which persons better acquainted with the profession might have studied to increase.

Mr. Robins says, that neither the distance to which a bullet flies, nor its force at the end of its flight, are much increased by very great augmentations of the velocity with which it is impelled; and, therefore, that, in distant cannonade, the advantages arising from long guns and great charges are but of little moment. Another of his maxims is, that whatever operations are to be performed by artillery, the least charges with which the object in view can be effected, should always be preferred.

In conformity with these maxims, Mr. Robins became a great advocate for reducing the length and weight of guns, for the purpose of enabling ships to carry ordnance of larger calibre.

79. Now these maxims entirely overlook the main desideratum, *accuracy of practice.* Mr. Robins also asserts that the objections which attach to short guns in batteries on shore, viz. ruining the embrazures, hold not at sea, where there is no other exception to the shortness of the piece than loss of force, which, in the instances here proposed, is altogether inconsiderable: but this is a very erroneous conclusion; for with carronades it is frequently impossible to place them so that, when fired, the flash should not burn the rigging or fire the hammocks in the barricade, without bringing the vent under the rail over the port, so as to expose the hammocks to the vent-fire, and the lock to injury when the piece is fired under depression. This is a very serious and a very well supported contradiction of Mr. Robins's conclusion; and the danger and inconvenience arising from the shortness of carronades have been so often noticed, that it is very expedient to make hereafter the 24, and particularly the 32-pounder carronade, a little longer in bore, and to add something to the flash-rim.

80. The advocates for the short gun system support their theory by quoting the deductions (Art. 107, 1st head,) from the ballistic experiments, from which it appears that the superior

velocity of shot discharged from long guns, is reduced to an equality with the velocity of balls from short guns, after passing over certain spaces; and that the extreme ranges do not much differ. But the main principle which should govern our choice of naval guns is, to prefer those which, with equal calibre, possess the greatest point-blank range; and the practical maxim for using them should be, to close to, or within that range, and depend upon precision and rapidity of fire. This is the most simple, and the most efficacious use of artillery; it avoids all the difficulty of determining, and the uncertainty in regulating elevation; and it is therefore of the greatest importance in naval gunnery.

81. The maxim to which I have first alluded, p. 102, relates only to *random ranges*, and overlooks the advantages arising from the superior accuracy of long guns at moderate distances, or line-of-metal ranges. Comparing the powers of the long 24-pounder, length 9½ feet, with those of the short 24, length 6 feet 6, we perceive, that, although the extreme ranges may be nearly the same, yet for practice at 300 yards, the long gun might be laid point-blank, whilst the latter would require nearly half a degree of elevation. At 1000 yards the former would only require an

elevation of 2°, which, with the short gun, would only give a range of about 800 yards. Such niceties of elevation cannot, perhaps, be accurately observed in ship-practice; but when guns, which do not range alike with the same actual elevation of cylinder, are opposed to each other, the chances as well as the power of accuracy are much in favour of the gun which requires least elevation, because the path of its ball coincides more with the horizontal direction. This should always be kept in mind, in naval practice particularly. To disregard this maxim, because the motion of the ship seems to mock the reckoning of half degrees, is evidently to add a great projectile inaccuracy to an error which, on the contrary, we should endeavour to reduce by every possible approximation; and we may depend upon it, that a well commanded vessel, fitted with long guns, might, by circumspectly keeping her long-gun distance, display this superiority over a vessel of superior rate, fitted with short guns of the same, or even of a larger calibre.

82. The preference which has of late years been so improperly given to guns of reduced lengths, has also been promoted by a very erroneous principle of estimating the powers of ordnance, according to their line-of-metal ranges.

To most of my readers it may appear unnecessary to notice so obvious a fallacy; but having frequently heard it advanced in support of the short-gun system, it is necessary to expose the fallacious doctrine. When a gun is laid by a sight taken over the line-of-metal, the axis of the cylinder is elevated, more or less, according to the dispart* of the gun. The disparts in degrees, as given in the 4th column of Table VII., show the actual elevations at which shot would be projected from the different natures of naval ordnance, when laid by line-of-metal. The ranges corresponding to these elevations may be taken, in proportion, from Table VIII. Now the greater the elevation, the less the accuracy; and whether the actual elevation at which the shot is discharged be determined by the line-of-metal, or any other sight, the consequent and corresponding loss of accuracy follows. Thus the line-of-metal range of a $6\frac{1}{2}$ feet 24-pounder gun is about 900 yards (Table VIII.); that of the 9 ft. 6 in. gun is about 860 yards; but (Table VII.) the actual elevation of the shot's departure from the short gun is $2\frac{1}{4}°$, and that from the long gun only $1\frac{1}{2}°$. Now

* Half the difference between the diameter of the gun at the base-ring and at the swell of the muzzle.

if these guns were opposed to each other at the distance assumed equal to their line-of-metal ranges, viz. about 900 yards, figs. 2 and 3, Plate III. will give some conception of the comparative chance of effect. The distances A B, C D, in both figures, are 900. The long gun being placed at A, fig. 2, the curve from thence is constructed to show the path of the ball whose elevation of departure was $1\frac{1}{2}°$. The curve from C, fig. 3, is constructed to show the path of the other, with an elevation of $2\frac{1}{4}°$. Now observing where these curves intersect the vertical lines E, F, G, drawn at equal distances from the guns, we perceive, distinctly, by the different lengths intercepted between the horizontal line and lines of fire, that at any distance, A F, short of that assumed, a shot from the long gun would be more likely to take effect, than the more elevated ball from the shorter gun. If the distance be greater than assumed, the balls will graze short, and the effect, depending, in that case, upon ricochet, will be much in favour of the smaller angle of incidence formed with the surface of the water, by the ball from the long gun. These two cases suppose the actual elevation not to be disturbed by the floating motion; but it is moreover evident, that any error of this nature

must, in general, be further to the disadvantage of the shorter gun. It should be remarked, however, that balls will not ricochet upon water, if the angle of incidence be above three or four degrees, and if the water be not tolerably smooth; and that firing to windward is not so favourable to ricochet, as firing to leeward, because, in this case, the lee sides of the waves (always the most abrupt or steep,) are presented to the direction of the practice.

83. Mr. Robins's maxim, (page 102), which I have next to remark upon, only concerns penetration, and also overlooks accuracy. Were the charges to be regulated by considerations relating to penetration only, the full charges need seldom be used in naval actions; for (Case IX). a charge of $\frac{1}{6}$ the shot's weight would undoubtedly be sufficient to drive a ball from any large gun through the side of a ship at 1100 yards. But with this small charge, it would require twice as much elevation to produce this range, as would be necessary with the full charge. Thus (Table VIII.) the range of a 24-pounder, with 4° of elevation, and 4*lb*. of powder, is 1160 yards; but with a charge of 8*lb*. it would only require 2° of elevation to produce a range of 1000 yards. *Accuracy*, I repeat, is the great object. To gain it, the elevation should be the

least possible, and not the charge, unless within point-blank range, or at close quarters, when, for the reasons given in Article 35, the charge may, in some cases, be reduced.

84. Mr. Robins's observation, which I have brought under my third remark upon his maxims, page 103, is undoubtedly, to a certain extent, useful; but a general application of it in practice would be extremely detrimental. He asserts that there is no other exception to the shortness of guns in naval gunnery, than loss of force; and that this objection is altogether inconsiderable. Now force, abstractedly considered, should not, it is true, lead to a preference of long guns; for a shot discharged from a short gun of the same nature, might have force more than sufficient for the intended purpose; but as superior force, or momentum, with shot of equal diameter and weight, arises from superior velocity, and as superior velocity requires, to certain limits, less elevation, and consequently gives greater accuracy, it is for this reason desirable to have long guns, not for the sake of *force*, but to gain *precision* at long ranges. To show the superior velocity of long guns over short pieces of the same calibre, I shall add the results of some late ballistic experiments, with the undermentioned natures of guns.

	Nature of Gun.	Weight.			Length of Gun.		Length of Bore.		Distances of Trunnions to breeches.		Calibre.
		Cwt.	qrs.	lbs.	ft.	in.	ft.	in.	ft.	in.	inches.
No. 1.	6-pr.	9	3	0	4	9	4	$4\frac{1}{2}$	1	$10\frac{1}{2}$	3·668
2.	6-pr.	12	1	16	6	0	5	$7\frac{5}{8}$	2	$5\frac{3}{4}$	3·668

The 6-pounders were fired with $1\frac{1}{2}$*lb.* and with 2*lb.* of powder.

With $1\frac{1}{2}$*lb.* charges, the velocities were as follows:

Gun No. 1, $1451\frac{7}{10}$ feet, per second of time.
Gun No. 2, $1497\frac{3}{10}$ feet, per second of time.

With the 2*lb.* charges the velocities were:

Gun No. 1, 1676 } feet, per second.
Gun No. 2, 1761 }

Two 24-pounders of different lengths were also fired. One 9 feet 6 inches long, the other 7 feet 6 inches.

With 4*lb.* of powder the velocities were:

Long gun, $1292\frac{6}{10}$ } feet, per second.
Short gun, $1242\frac{1}{2}$ }

85. After a full consideration of all these facts and observations, the propriety of arming our second class of frigates with the short 24-pounder, instead of the long 18, may be doubted; and I am firmly of opinion, that our first class frigates should all be calculated for the 8 feet

24-pounder gun. The difference between the weight of the 6 feet 24-pounder, and that 8 feet long, is 16 *cwt.* 2 *qr.*; but the tonnage required for shot is the same, and there is not much difference in that required for powder.

86. The disadvantages we suffer from the numerous inferior classes of frigates in our navy have been severely felt. From not having had a sufficient number of frigates capable of bearing the nature of armament which was likely to be opposed to them in the late war, we were obliged, in common prudence, to employ two vessels, where one of superior force might have answered better. Frigates capable of bearing the 8 feet 24-pounder are certainly vast, and expensive ships; but they perform their service at a cheaper rate, and in a much more certain and creditable manner to the nation, than two vessels of very inferior rate. The full service of two ships acting against traders and privateers, cannot be effected without frequently parting company; and then the honour and interest of the flag they wear are at risk, from exposure to unequal combat; whilst the enemy's force, against which these *two* inferior vessels may have been sent, remains always entire. Two ships, once divided, may be beaten in detail, by a vessel by no means a match for both together; but the

honour of the large ship is always secure, and the chance of capture remote. She *may* meet a superior; but if so, to take her would be creditable—to yield no disgrace. A fleet of line-of-battle ships must keep together, resisting all temptations to chase single ships; but two vessels sent to cruise on predatory service, will only exert half their powers, by keeping company; for this restrains separate exertion, halves the chance of meeting an enemy, and when one is discovered, there always ensues a chance of the two vessels parting company in the chase.

87. The American frigates of the large class all carried long guns. The President had, on the main-deck, 24-pounders, length $8\frac{1}{2}$ feet, weight $48\frac{1}{2}$ *cwt.*; on the quarter-deck and forecastle, 42 *lb.* carronades, length 4 ft. 4 in.; both English calibre. The Chesapeake mounted on the main-deck, twenty-eight 18-pounders, length 7 ft. 8 in. weight 39 *cwt.* 1 *qr.* and twenty 32 *lb.* carronades, nearly of British pattern. The Essex, on the contrary, was armed almost exclusively with carronades; and the effect of this we shall examine hereafter.

88. The 18-pounder, length 9 feet, is an excellent gun, (see note, Table VIII.); and, for naval service, preferable to any 24-pounder of reduced length. Its ranges are about the same

as the long 24, with like elevations. Its point-blank range is nearly 100 yards greater than that of the 6 feet 24-pounder; and at 1° the 18-pounder ranges nearly as far as the short 24-pounder does at 2°. It is true that the superficial fracture made in the side of a ship by a 24*lb.* shot, is larger than that made by an 18*lb.* ball, in the proportion of the squares of their diameters, and that the former will also penetrate further than the latter; but (Case IX. Art. 99, 100.) as this quality is not deficient in the 18-pounder, even with a very reduced charge, the difference between the magnitudes of the perforations should not weigh against the superior power of range, and consequently superior accuracy, of an 18-pounder long gun.

89. Viewing the matter purely as an artillery question, there is no doubt that preference should be given to long guns. As to its application to naval matters, I do not hesitate to recommend, that a frigate which cannot carry 8 feet 24-pounders, had better be fitted with long 18-pounders, than with 6 or 6½ feet 24's, or with any nature of carronade, exclusively. The chief objection that may be made to this is, that short 24-pounders are more easily worked, sooner loaded, and run out. This I admit; but surely, with a good strong crew, the difference

would be very inconsiderable; and, at all events, not worth the sacrifice of such vast superiority of power and practice at long ranges. Perhaps also, as we shall show hereafter, expedients may be devised to lessen this, the only disadvantage that can be objected to long guns, for vessels that can receive them.

90. Much of the reasoning contained in the preceding articles attaches to carronades. At close quarters they are very formidable; but at long ranges they are no match for long guns, even of much smaller calibre (compare Tables VIII. and XV.): and any vessel fitted exclusively with carronades might, undoubtedly, be destroyed or captured by a vessel of very inferior rate mounting long guns, if her commander knew how to avail himself of the great superiority of his weapons.

91. The very mortifying situation in which the gallant Sir James Yeo found himself, in September 1813, on Lake Ontario, shows the danger of the carronade system of armament. Sir James states, in his letter of the 12th September, "the enemy's fleet of eleven sail, having a partial wind, succeeded in getting within range of their *long* 24 *and* 32-*pounders*; and, having obtained the wind of us, I found it impossible to bring them to close action. *We remained in*

this mortifying situation five hours, having only *six guns in the fleet that would reach the enemy.* Not a *carronade was fired.* At sun-set a breeze sprung up from the westward, when I manœuvred to oblige the enemy to meet us on equal terms. This, however, he carefully avoided."

In Sir James's dispatch of the 15th November, he mentions in strong terms the deficiency of long guns in the Lake Erie squadron.

Captain Barclay states, in his letter of the 12th September 1813:—"The other brig of the enemy, apparently destined to engage the Queen Charlotte, supported in like manner by two schooners, kept so far to windward, as to render the Queen Charlotte's 24-pounder carronades useless, whilst she and the Lady Prevost were exposed to a heavy and destructive fire from the Caledonian and four other schooners, armed with *long* and *heavy guns.*"

The action of the Phœbe with the American frigate Essex, illustrates and confirms, though happily in a reverse sense, all I have said on the serious dangers of the carronade system of armament, opposed to a vessel, fitted with long guns, commanded and managed as the British frigate was. The Phœbe mounted long 18-pounders on the main-deck, and 32-pounder carronades on the quarter-deck and forecastle. The Essex

had forty 32-pounder carronades, and only six 12-pounder guns, length 6 feet $8\frac{1}{10}$ inches. Captain Porter, of the Essex, says—"The Phœbe by edging off was enabled to choose the distance which best suited her long guns, and kept up a tremendous fire, which mowed down my brave companions by the dozen." Again—"The enemy, from the smoothness of the water, and the impossibility of reaching him with our carronades, was enabled to take aim at us as at a target; his shot never missed our hull, and my ship was cut up in a manner which was perhaps never before witnessed."

This action displayed all that can reflect honour on the science and admirable conduct of Captain Hillier and his crew, which, without the assistance of the Cherub, would have insured the same termination. Captain Porter's sneers at the "respectful distance" the Phœbe kept, are, in fact, acknowledgments of the ability with which Captain Hillier availed himself of the superiority of his arms; and this brilliant affair, together with the preceding facts, cannot fail to dictate the necessity of abandoning a principle of armament exposed to such perils; and to teach the importance of adapting the tactics of an operation to the comparative natures and powers of arms.

92. This unfavourable view of the service of carronades may, at first sight, appear unsatisfactory to those who have been accustomed to consider their abstract merits, rather than their comparative powers; but I am persuaded that when the subject comes to be duly considered in its relative bearing, the dangers and defects arising from too great an extension of this arm will be strongly felt, and its *abuse* prevented; for, besides the cases just cited, professional men must be aware of many other facts that might be brought to support this reasoning. It will naturally be asked why, if this be the case, should carronades be used at all; or, if admissible, in what cases should they be applied. To this it may be answered, that although carronades are certainly imperfect guns, yet they are extremely useful on account of their lightness, and the small space they occupy. The cases to which they should be applied may be reduced to two, viz. For the quarter-decks and forecastles, excepting bow and stern-chasers, of frigates and larger vessels;—and secondly, though not exclusively, for small vessels which are incapable of carrying guns of any considerable size; but it is very important that vessels thus armed should possess the quality of quick sailing.

93. In the only table of carronade practice that has hitherto been published, (Table XIII.)

the ranges are marked in terms so inconsistent with the circumstances under which the practice was conducted, that I have noticed it for the purpose of showing how much it is calculated to mislead the practitioner, by having over-rated the powers of this nature of ordnance. The battery having been placed from 9 to 12 feet (this is too vague an explanation for the correct guidance of practice) above the level of the water, the ranges marked in the table at point-blank, and at 1°, 2°, 3°, 4°, 5° of elevation, were, in point of fact, the first grazes of balls, projected in the above directions, upon a horizontal plane "from 9 to 12 feet" below the level on which the carronades stood. The practical man consulting this table, as must often have been done on occasions deeply involving the interests of our country and the honour of our flag, would take out the point-blank ranges of 42, 32, and 24-pounder carronades, with charges less than the service quantities, equal, at least, to the point-blank ranges of the corresponding natures of long guns; and all the higher ranges of the carronades are proportionally over-rated. Regulating the elevation according to this table, most of the shot would strike the water, if, as is most commonly the case, the distance have been under-rated; and if correctly estimated relatively with the

practice marked in the table, all the shot would be directed too low. May not this account for the numerous and vague assertions that have been made of weak powder, and shot falling short? Short! by what rule?—by these erroneous rules of practice. It may be from this exaggerated exhibition of the powers of carronades also, that naval men have been led to estimate them too highly—to adopt them too generally, and, in some cases, unhappily, *exclusively;* producing, as we have seen, the most serious consequences. In all tables of practice for naval service, the ranges should be reported with reference to the horizontal plane upon which the piece stands, and not as amplitudes upon a plane considerably and indefinitely beneath this level.

94. Table XV. is a more correct register of powers of carronades.* From this it appears, that the range of a 24-pounder carronade at point-blank is only about 218 yards with 3*lb.* of powder. Now, to combine their effect properly with long 18 and 24-pounder guns at their

* The elevations of carronades, as given by the notch sights, are as follow. The line taken over the base-ring and the upper shoulder of the notch is point-blank. From the base-ring using the middle shoulder of the notch is $2\frac{1}{2}°$. From the same point, using the bottom of the notch, is $3\frac{1}{2}°$.

point-blank, the carronades similarly laid from the quarter-deck of a frigate would hit too low. The greater height of the quarter-deck of a two-deck ship is much more favourable to the carronades, because the errors arising from their ranges having been so much over-rated, have more space to take effect in. In a mixed armament of guns and carronades, the latter co-operate powerfully with the former, at close quarters; and are protected by the guns below from being attacked with impunity at long ranges, which we have seen may be the case, if the armament be *exclusively* carronades.

In support of the observation, that the quality of quick sailing is essential to carronade-armed vessels, it should be remarked that, as the faculties of this nature of ordnance are peculiarly adapted to close actions, and entirely disappear at long ranges, vessels thus fitted should be well able to choose their distance; and this they can only do by being quick sailers.

CASE VIII.

To determine the Effects produced on the Velocity of the Ball, by varying the Weight of Gun; and by restricting or preventing the Recoil;—Charges and Shot constant.

95. Varying the weight of the gun produced no change in the velocity of the ball. The guns were suspended in the same manner as the pendulous blocks, and additional weights were attached to the pieces, so as to restrain the recoil; but although the arcs of the recoil were thus shortened, yet the velocity of the ball was not altered by it. The recoil was then entirely prevented, but the initial velocity of the ball remained the same.

96. It has been supposed, and is still very generally maintained among practical men, that uncertainty in artillery practice is much increased by the irregular motion of the gun in its recoil, and that by preventing this action, this error would be corrected, and the shot be projected to a greater distance. Upon this notion chiefly the non-recoil principle was founded, and

much maintained in our naval service. Now the recoil of an 18-pounder, charge 8*lb.* corresponding to the time in which its shot is passing along the bore, is only ·2218, or less than one fourth of an inch. This is calculated upon the following principle.—Gunpowder, when fired, endeavours to expand with equal force in every direction, and consequently acts equally upon the bottom of the bore, and upon the ball in its passage along the cylinder, supposing no loss of force by windage, i. e. the ball to fit tight. The velocity of the gun in its recoil, and that of the ball, are therefore inversely as their weights, a sufficient allowance being made for friction. The weights moved in the two directions (viz. the shot along the bore, and the corresponding recoil of the gun) being known, and the time and moving force being the same, the spaces are inversely as the quantities of matter moved. The space which the shot passes over is the length of the bore (reckoned from the place where the shot lies) minus the space which the gun recoils in that time; the quantities of matter are also known; hence the corresponding recoil, the unknown quantity, is found, from an equation formed from the above proportion, to be ·2218, or $\frac{2}{9}$ of an inch.

It is scarcely possible to prevent the recoil

corresponding to the time of the shot passing along the bore; for it appears, that even a shake or play of about $\frac{1}{8}$ of an inch, is sufficient for this with an 18-pounder, charge 8*lb.* When the reaction arising from any further recoil being prevented, *does* come, the shot is not affected by it. The degree of recoil corresponding to the flight of the shot along the bore, is sufficient however to explain the known fact, that any accident happening to the gun or carriage at the moment of firing, such as the bed or a coin breaking, or flying out—a truck coming off, or a trunnion breaking, sensibly affects the length as well as the direction of the range.

CASE IX.

The Penetration of Balls of different Natures, and with various Charges, into Masses of Timber.

97. The results of the different experiments to ascertain the quantity of penetration, were various, arising no doubt from inequality in the consistency of the blocks of wood, and from different degrees of

elasticity; but they yield with certainty, the following conclusions, viz.

1st. That if equal balls be discharged against a mass of timber, the depths of the cavities will be nearly as the squares of the velocities.

2dly. That unequal balls, of the same matter, discharged with the same velocity, will penetrate to depths proportioned to their diameters; so that a greater ball will not only make a larger hole, but will also penetrate further than a small ball discharged with the same velocity.

98. The penetration of balls into solid blocks of elm, with a brass one-pounder, length 40 inches, weight 289*lb.* were as follows:

Weight of Powder.	Penetration.	
2 *oz.*	7 *in.*	By a mean taken of several rounds.
4	15	
8	20	

These penetrations are nearly as 2, 4, 6, or 1, 2, 3; but the charges are as 2, 4, 8, or 1, 2, 4; so that the penetrations are as the charges up to four ounces, but in a less ratio with a charge of 8 *oz.* instead of being proportional to the charges, or, which is the same thing, as the

squares of the velocities throughout. This increase of the resisting force of wood to great velocities, Dr. Hutton attributes to the greater quantity of fibres driven before the ball, which thus increases the spring and resistance of the wood.

99. An 18-pounder, with a charge of one pound of powder, was fired at a butt formed of oak planks $6\frac{1}{2}$ inches thick, crossed upon each other, forming, consequently, a mass 13 inches thick. At 30 yards the shot always passed through, driving the splinters from 10 to 30 yards distance.

100. Another butt was formed of five thicknesses of plank, instead of two, consequently $32\frac{1}{2}$ inches thick. The planks were placed perpendicularly and horizontally alternately, each plank tree-nailed to the next behind it, and the whole mass well bound together. An 18-pounder, discharged successively with $3\frac{1}{2}$, 3, and $2\frac{1}{2}$*lb.* of powder, perforated the butt each time, driving great quantities of splinters before it; but the lowest charge, viz. $2\frac{1}{2}$*lb.* occasioned the greatest ravages, for it drew the tree-nails —separated the double planks from each other —and broke the inside plank short in two.

101. A third butt was then made of beams of well-seasoned English oak, about a foot and a

half thick, and two feet broad. Three of these were set perpendicularly into the ground, close to each other; then three laid on each other horizontally, and three more set perpendicularly behind. The whole were then firmly bolted together by iron bolts, $1\frac{1}{2}$ inch in diameter, forming a solid mass $4\frac{1}{2}$ feet thick.

102. An 18-pounder being fired with six pounds of powder, the balls, in several rounds, penetrated into this mass from 37 to 46 inches.

With 3*lb.* the penetration was about 30 inches.

With $2\frac{1}{2}$*lb.* the penetration was about 28 inches.

With 1*lb.* the shot penetrated from $14\frac{1}{2}$ to $15\frac{1}{2}$ inches.

103. A $6\frac{1}{2}$ feet 24-pounder, double shotted, was fired with 4*lb.* of powder, at a butt of timber 5 feet 2 inches thick, placed 100 yards from the gun:—most of the shot perforated the butt, and ruined two gun carriages placed behind it.

104. An 18-pound shot, fired with a charge of 4 *lb.* penetrated 34 inches into dry elm—whence it appears, that elm timber resists less than oak, in the ratio of about 17 to 19.

CASE X.

To determine the Effects produced by different Degrees of Ramming; and by using Wads of different Degrees of Tightness.

105. It appeared that different degrees of ramming, or different dimensions of wads, made no sensible alteration in the velocities of the ball as determined by the vibrations of the pendulum. Stout, firm, junk-wads, so tight as with difficulty to be rammed into the gun, were used: sometimes they were placed between the powder and ball, sometimes over both—but no effect was discovered in the velocity of the ball. Different degrees of ramming were also tried without wads. The charge was sometimes set home without being compressed—sometimes rammed with different number of strokes, or pushed up with various degrees of force; but the velocity of the ball remained the same. With small balls, i. e. great windage, the vibrations of the pendulum were much reduced, although

tight wads under the shot were used; so that wads do not prevent the escape of the inflamed powder by the windage, nor under any circumstances occasion any sensible difference in the velocity of the ball.

106. This being clearly established, tight wads should not be used in action, because they increase the difficulty of loading, without doing any good: they may be used in loading guns before an affair; but with a view to quick firing, the wads used in action should be no tighter than is necessary to prevent the charge from shifting while the gun is run out. I have occasionally seen the operation of ramming home a tight wad take up two or three minutes. This is a very serious and unnecessary waste of time. When a wad is so high, or tight, as to require the force of a *blow*, instead of a *push*, it spreads from the stroke, and consequently becomes harder, and more difficult to be moved. Care should therefore be taken to provide easy wads, correctly gauged, and made so as to spread to pressure sufficient to retain the charge from shifting, upon being set up with a smart blow.

CASE XI.

To compare the actual Ranges and Times of Flight, with the initial Velocity obtained from the Motion of the Pendulum, in order to determine the Effect of the Resistance of Air.

107. It was found that the resistance of the air to the flight of balls with the velocities used, was somewhat higher than the squares of the velocities throughout.

To determine the quantity of resistance to any degree of velocity of ball, the ballistic pendulum was set at different distances, and shot discharged into it, to ascertain the velocity lost in passing through different spaces.

The pendulum was placed at the distances of 30, 60, 120, 180, 240, 300, 360 feet; beyond which it was not found practicable to proceed, on account of the uncertainty of hitting the pendulum.

From these experiments, the Table III. Art. 110. is formed, and the following general inferences drawn.

1st. That there is very little advantage obtained by any increase in the length of guns, beyond a certain limit; since the superior initial velocity of shot from long guns is reduced to an equality with those from short guns, after passing over certain spaces.

2d. That there is no advantage in increasing the charge beyond what is necessary to produce a certain velocity; since the increased resistance soon reduces it to an ordinary celerity.

3d. It was confirmed, that the velocities are nearly in the proportion of the square roots of the charges.

4th. That there is a gradual and regular increase of resistance, as the velocity is increased, as far as a velocity of 1400 feet per second, when the vacuum behind the ball being complete; (23) the resistance is greatest, and is then as the $2\frac{1}{4}$ power of the velocity nearly; after which the resistance gradually decreases, as the velocity increases, till it arrive at about the $2\frac{1}{20}$ power; a law unknown till it was discovered by these experiments.

108. These deductions convey very valuable information as to the proper dimensions of guns, weight of charges, &c. &c. but no rules for practice can be obtained, until the precise law of resistance be known. All that can be done, until a perfect knowledge of the nature and law of resistance be obtained, is, to collect together some of the best practical rules, founded partly on theory, and partly on practice; from which, (as Dr. Hutton as given them,) and the cases they are applied to, many useful deductions follow, to guide us in improvement, or at least to prevent us from falling into error.

109. The initial, or first velocity of a ball, may be determined from the following table of experimented ranges, by rules, Case II. art. 33; and Case III. art. 36; viz.—That the velocities of different balls, with different charges of powder, are as the square-roots of the weight of powder directly, and inversely as the square-roots of the weights of the balls.

TABLE II.

Balls.		Powder.	Elevation of Gun.	Velocity of Ball.	Range.	Time of Flight.
Weight.	Diameter.					
oz. dwt.	inches.	ounces.	degrees.	feet.	feet.	seconds.
16 5	1·96	2	15	860	4100	9
16 8	1·96	4	15	1230	5100	12
16 12	1·96	8	15	1640	6000	14½
16 12	1·95	12	15	1680	6700	15½
16 10	1·96	2	45	860	5100	21

To determine the initial velocity of a 24*lb.* ball discharged with 8*lb.* of powder. By the table it appears that 8*oz.* of powder discharged a 1*lb.* ball with a velocity of 1640 feet. Then as $\sqrt{\frac{8}{1}}\,oz. : \sqrt{\frac{128}{24}} :: 1640 : 1640 \sqrt{\frac{16}{24}} = 1640 \sqrt{\frac{2}{3}} = 1339$, the velocity of the 24*lb.* ball.

110. The resistance of the air to a ball discharged with any velocity, may be determined from the following Table.

TABLE III.

Resistances to a Ball of 1·965 *inches Diameter, and* 16 *oz.* 13 *dwts. Weight.*

Velocity.	Resistance.
feet.	lbs.
100	·17
200	·71
300	1·61
400	2·91
500	4·65
600	6·90
700	9·75
800	13·25
900	17·52
1000	22·63
1100	28·56
1200	35·28
1300	42·71
1400	50·72
1500	59·19
1600	68·93
1700	76·78
1800	85·54
1900	94·11
2000	102·36

Thus to determine the resistance of the air against a 24*lb.* ball, discharged with a velocity of 2000 feet in a second. By the Table it appears, that the ball of 1·965 inches diameter, with a velocity of 2000 feet, suffered a resistance of 102·36*lb.* The resistances, to equal velocities, being as the surfaces of the balls, i. e. the squares of their diameters, we have as 3·86 (square of 1·965) : 31·36 (square of 5·6 diameter of 24*lb.* ball,) : : 102·36 : 829*lb.* the resistance to a 24*lb.* ball with a velocity of 2000 feet in a second.

111. But in computing these resistances, the decrease in the density of the air upwards has been disregarded; whereas projectiles are less and less resisted as they ascend, and consequently rise to greater heights than if the medium were of uniform density. To determine the difference resulting from this, it is necessary to know the greatest velocity any ball can acquire in descending through the air, that is the terminal velocity with which the ball will uniformly descend when the resistance becomes equal to the urging force, that is, equal to the weight of the ball.

112. To ascertain the terminal velocity of a ball weighing 1·05*lb.* it appears, first, from Table III. Art. 110, that the resistance 1·05,

and the corresponding velocity, fall between ·71 and 1·61. But the resistances being nearly as the squares of the velocities, when these are not very different, and having the velocity 200 answering to the resistance ·71, we have, as $\cdot 71 : 1\cdot 05 :: 200^2 : v^2 = 59049$; and $\sqrt{59049} =$ 243 feet, the greatest velocity a ball of the weight 1·05*lb.* can acquire in descending through air.

113. For any other weight of ball, the resistance to balls of different weights (being as the surfaces), increase as the squares of their diameters—or one power less than the increase of weight (or urging force), which is as their cubes. Now the resistance being as the squares of the velocities nearly, we must increase the square of 243 feet, the velocity just found, in the ratio of the diameters, to find the terminal velocity of any other ball. From this Doctor Hutton formed the following Table, in which the terminal velocities corresponding to all natures of balls are given, and the heights from which they must descend, in vacuo, to acquire such celerities.*

* The celebrated Mr. Carnot has entirely overlooked the circumstance of *terminal velocity* in his proposition for defending besieged places by means of vertical fire. Applying the above investigation of the terminal velocites of different solids to his project, I soon discovered that he had not allowed for

TABLE IV.

Weight of Ball.	Diameter of Ball.	Terminal Velocity.	Height due to terminal Velocity.
lbs.	inches.	feet.	feet.
1	1·923	247	948
2	2·423	277	1193
3	2·773	297	1371
4	3·053	311	1503
6	3·494	333	1724
9	4·000	356	1970
12	4·403	374	2174
18	5·040	400	2488
24	5·546	419	2729
32	6·106	440	3010
36	6·350	449	3134
42	6·684	461	3304

114. When the initial velocity is known, the elevation which produces the greatest range, and that range, may be found from the Table V. formed by Doctor Hutton, from an approximation of Sir I. Newton's.

To use this Table, divide the initial velocity by the terminal velocity peculiar to the given ball in Table IV. and with the quotient, enter

the prodigious effect of resistance; and in my Observations upon his Work, I have endeavoured to expose the fallacy of a system erroneous in principle, and any application of which must, for other reasons also, be either enormously expensive, or extremely insecure.

the first column in Table V.—the corresponding elevation will be found in the second column; and the number opposite, in the third column, multiplied by the altitude due to the terminal velocity (Table IV.) will give the range nearly.

TABLE V.

Table of Elevation giving the greatest Range.

Initial Velocity divided by the Terminal Velocity.	Elevation.	Range divided by the Altitude due to Terminal Velocity.
0·6910	44° 0′	0·4110
0·9445	43° 15′	0·6148
1·1980	42° 30′	0·8176
1·4515	41° 45′	1·0210
1·7050	41° 0′	1·2244
1·9585	40° 15′	1·4278
2·2120	39° 30′	1·6312
2.4655	38° 45′	1·8346
2·7190	38° 0′	2·0379
2·9725	37° 15′	2·2413
3·2260	36° 30′	2·4447
3·4795	35° 45′	2·6481
3·7330	35° 0′	2,8515
3·9865	34° 15′	3·0549
4·2400	33° 30′	3·2583
4·4935	32° 45′	3·4616
4·7470	32° 0′	3·6650
5·0000	31° 15′	3·8684

Examples.—To find the greatest range of a 24*lb.* ball, discharged with a velocity of 1640

feet in a second, and the corresponding angle of elevation to produce that range. The terminal velocity of a 24*lb*. ball (Table IV.) is 419, and its corresponding altitude 2729. Then $\frac{1640}{419} =$ 3·91, nearly, equal to a mean between 3·733 and 3·9865 in the first column of Table V. to which corresponds the mean elevation 34° 37′; then the number 2·9532, a mean between 3·0549 and 2·8515 in the third column, multiplied by 2729, the height due to the terminal velocity, Table IV. gives 8059 feet, or upwards of a mile and a half, for the greatest range.

In like manner, to find the greatest range of a 9*lb*. ball, with an initial velocity of 1500 feet in a second.

$\frac{1500}{356} = 4{\cdot}21$, which is nearly equal to 4·24 in the first column of Table V. The corresponding elevation is 33° 30′, and the number 3·2583 in the third column, multiplied by 1970, height due to the terminal velocity 356, gives 6418 feet, or 2039 yards nearly.

115. These examples, and the Table V. are only adapted to the ranges of cannon balls. By these cases it appears, that the greatest ranges of guns are very considerable; but it is not usual to discharge cannon-shot at great elevations, on account of the uncertainty of such practice; nor indeed is it practicable to do so—this is only

practised with mortars. The terminal velocities of shells being less than those of balls of the same diameter, Doctor Hutton has given the following Table of the terminal velocities of, and heights due to, all natures of shells.

TABLE VI.

Table of Dimensions, Weight, Terminal Velocity, and Altitude due to Terminal Velocities of Shells.

Diameter of Mortar.	Diameter of Shells.	Weight of Shells filled.	Weight of equal solid.	Ratio of Shell to solid.	Terminal Velocity.	Altitude due to Terminal Velocity.
inches.	inches.	lbs.	lbs.		feet.	feet.
4·6	4·53	9	12¾	1·42	318	1580
5·8	5·72	18	25½	1·42	356	1980
8	7·90	47	67	1·42	420	2756
10	9·84	91½	130	1·42	468	3422
13	12·80	201	286	1·42	534	4430

Column 3 shows the weight of the shell filled with powder—column 4, that of solid iron balls of the same size; and the ratio of these weights is given in the fifth column. Shells being lighter than equal solid iron-balls, in the ratio of 1 to 1·42, have, in that proportion, less power to oppose resistance; and the greatest, or terminal velocity, as given in the sixth column, will be less in proportion. The seventh

column shows the heights due to these velocities in vacuo. From this Table, and Table IV. the greatest range, and corresponding angle of elevation of mortars may be determined.

116. Thus to find the greatest range and corresponding angle of elevation for a 13-inch shell, discharged with a velocity of 2000 feet in a second; 2000, the initial velocity, divided by 534, the terminal velocity, taken from Table VI. gives 3·74; opposite to which in Table V. the elevation 35° will be found to correspond. Then the number 2·8515 (corresponding in proportion), obtained from the third column of Table V. multiplied by 4430, the altitude due to the terminal velocity of the shell, (column 7, Table VI.) gives 12632 feet, (about $2\frac{1}{3}$ miles,) for the greatest range.

Thus it appears, that even with the largest shells, particularly when the charges are great, there is a very considerable deviation from the parabolic theory, according to which 45° of elevation should give the greatest range. With sea mortars, when small charges are used, the cases for practice may be solved according to the deductions in Article 9; but with the full charges these will lead to error. (20.) The elevation required to produce the greatest range of

a 13-inch shell, discharged with a velocity of 1500 feet per second, is 37° 37′.

With a 10-inch mortar, the elevation corresponding to the greatest range of a shell projected with the above velocity, is about 36½°.

117. From this it follows, that instead of fixing all mortars in their beds at 45° of elevation, the angle should be that which, with the full charge, gives the greatest range. Power of range, from mortar vessels particularly, is a very great consideration, because they cannot always choose their distance; and this power is unnecessarily restricted, and, consequently, means wasted, by assuming the greatest range to be always due to an elevation of 45°.

Referring to Table V, it will be seen how much the ranges are affected by small differences in elevation, with great velocities of projection; and, consequently, how important it is to know, and to be able to regulate as nearly as possible, the actual angle of the shell's departure. This being liable to great uncertainty in mortar practice from bomb vessels, on account of the floating motions, I was induced, in 1804, to suggest and introduce locks for sea mortars, which till then were fired by matches. The lock enables the bombardier to discharge the

mortar critically at the instant the vessel comes to a proper position; and the practice might be rendered less uncertain by observing a pendulum, or where there is not much motion, by using a large spirit-level fixed in any convenient place in the same plane as the upper surface of the mortar-bed, to point out the average angle of heel of the vessel, and thus regulate the actual elevation of the shell's departure.

118. The astonishing range of the mortar used by the French at the siege of Cadiz has already been mentioned, Art. 38, page 61. To find the range of a 13-inch shell, filled with lead and discharged with a velocity of 2000 feet per second from a British mortar:—the weight of a solid of lead, nine inches diameter, to fill the cavity, is 139·3*lb.*; this added to 187·8*lb.* the weight of the shell, gives 327*lb.* for the total weight. The terminal velocity of this ball, computed by the theorem or expression 175·5 $\sqrt{\frac{d}{\text{ratio}}}$* (see Third Vol. Hutton's Course, page 301) is 670, and its corresponding altitude 7014. Then $\frac{2000}{670}=2·985$, opposite to which in Table V. we find 37° 15′ for the elevation producing the greatest range; and in the third column the

* Ratio of the weight of an equal solid of iron, viz. 286*lb.* to this compound solid of 327*lb.*

number 2·2413, which multiplied by 7014, (the altitude due to the terminal velocity,) gives 15726 feet, or nearly three miles, with $37\frac{1}{4}°$ elevation. The assumed velocity, 2000 feet in a second, cannot, perhaps, be produced with mortars, but the range may certainly be much increased by this expedient; at the sacrifice, however, of the effect that might be produced by the bursting of the shell, according to the ordinary practice.

PART III.

ON THE MANUAL OF NAVAL GUNNERY.

119. No established form of Exercise existed in our naval service until the year 1817, when the Admiralty appointed a committee of officers to digest and arrange a new system of Gun-exercise.

Whether that system have been finally approved for general adoption, or be retained for further consideration, I am uncertain; but ignorant, at all events, of its precise form, (I have never seen it,) it will not, I hope, be thought superfluous or unnecessary that I should treat of so important a branch of this subject, notwithstanding the professional arrangements that are making to improve and systematize it.

Recurring earnestly to the plan detailed in Part I. as often as I come to treat of any matter of application that can support that proposition, I must here observe, that the mere arrangement of a manual for the drill, is making but very trifling progress in the improvement of the practice of Naval Gunnery. It is indeed only

the first step towards it; for, if no means be provided for instructing, previously, master-gunners and gunners'-mates, they must be drilled themselves, after the ship to which they may be appointed is commissioned, before the crew can be brought under proper instruction. This process may do well enough when there is time to proceed accordingly; but, applied to a state of prompt preparation for actual service, it is clear that it only insures uniformity in what is thereafter to be learnt, but does not provide for the previous training of those whose business it is to teach. It will be too late to begin to form instructors, at the time they are wanted to teach others; and, as in the old practice, it must therefore be left to the gunner to exercise the crew to the guns, in any manner in which he may have been accustomed to act; or he may not be qualified even in this inferior degree. In every case, much must depend upon the knowledge and intelligence of the person holding this important office. Now if the prescribed manual were reduced to practice (page 19) in an establishment such as has been detailed, though it were only to train master-gunners and gunner's-mates, a great, and not a very costly improvement would be made in this great national object.

As the form of exercise that has been established at the Admiralty for the service of naval ordnance will be circulated, officially, when required, to all concerned, I shall not enter on those details which I had contemplated for forming a naval manual. It may not be useless, however, to offer some general remarks on this subject; and, as in seeking to improve any branch of practice, it is always advantageous to be well acquainted with the corresponding systems which may have been matured by the experience of nations to which we may hereafter be opposed, I shall notice, at some length, the *French Manual*, (published in 1815,) from which some useful matter may be extracted, and to some of the provisions of which I shall have occasion to refer.

120. It appears to me, that the mode of stationing and distinguishing the crews of ordnance in the French code, is extremely simple, and preferable to the practice of designating the people by numbers throughout. The principle of numbering off the crew of a gun, as practised very properly in the land service, has of late been a good deal followed in the navy, and it forms the basis of the new system to which I have already alluded. Though fully impressed with the advantages of such an arrangement for land-

service, I more than doubt the expediency of adopting it generally in the naval service. Artillery soldiers numbered off to a gun, are not liable to be called away suddenly, in the heat of action, to the performance of other duties assigned to them also by numbers. But naval gunners are told off not only to their gun-duties, but to other very important callings, some of which must be designated by numbers, as far at least as two or three places. When calls, by numbers, are made upon men stationed by numbers to their guns, it may fairly be apprehended that some confusion or hesitation may ensue, particularly if that call should be made after having sustained any casualty that may disturb that division of labour, and order of succession to other duties, which were originally provided for in the numerical classification. For the various manœuvres of tacking and wearing, making and shortening sail, trimming sails, boarding, extinguishing fire, small-arm duties, &c. the men are told off, by numbers, as far as two or three places at least. Thus, 1st sail trimmers, or 1st and 2d small-arm men, or 1st and 2d boarders, may be called; but they may have changed their original gun-numbers more than once, and all this complication of numbering is burthening the men's memories in a manner

that may occasion some hesitation in obeying such calls, and some confusion in the substitute arrangements at the guns. These inconveniences and objections to numerical designation were so strongly felt during service, that in some of our best *men-of-war* the practice was abandoned, and the men stationed, as much as possible, by appellations expressive of their duties. This is the principle also of the French Manual, in which the men are called chiefs, chargers, loaders, providers, 1st and 2d right-men, 1st and 2d left-men, &c.

In the Shannon the men were designated 1st and 2d captains, loaders, loader's mate, 2d loader—these taken from the ablest and most intelligent men; then tackle-men, powder-men, lantern-men. From the first class were taken boarders, sail-trimmers, and firemen, when called. From the second class, or mere assistants, were taken small-arm men, &c.

For action on both sides, the 2d captain of each gun became acting captain of the opposite piece, and the 2d loader, its charger, and so on. The crews of the guns were told off to starboard and larboard watch, alternately, so that they might be exercised in complete complements, in their respective watches, and thus know, and have confidence in each other, and

be accustomed to act together. Then each gun-crew was subdivided into two classes; and whenever, as at night or otherwise, it became necessary to prepare the guns for action, without however disturbing the watch below, the second division of each gun-crew upon deck cleared and prepared the adjoining piece belonging to the other watch, who were not consequently turned out till called for action. In long anxious chases of large vessels of uncertain appearance, these excellent arrangements must have been of infinite use, in sparing the men from fatigue, without relaxing any thing of service efficiency.

Much might be said upon the importance of stationing men to duties about the guns by appellation, in preference to the arrangement by numbers, and upon the necessity of making this appropriation subservient, not only to the talents and fitness required for duties about the gun, but to the qualities and powers required for other duties to which the men may be called. All this demands intimate knowledge of the several qualities of the whole crew— occasional alterations in proportion as these are discovered, and, consequently, various modifications in the manual system. This view of the subject again shows the indispensable necessity of intrusting the instruction of naval gunners ot naval characters only: for the arrangement

of the duties about the guns, is intimately mixed up with that which best provides for duties of seamanship and manœuvring, with the least possible interruption to the service of the ordnance; and these are altogether formed from data more favourable to the arrangement by appellation, than to the system of numbers.

These general remarks will not, I hope, be thought altogether useless; but reserving what I may have further to advance on the subject of Exercise, till a future publication, should it ever be called for, I shall now proceed to notice the French code that has been revised and improved, to endeavour to recover that expertness in practice which they once possessed; but which they utterly lost in the last war.

EXERCISE AND MANŒUVRE OF ORDNANCE ON BOARD FRENCH SHIPS OF WAR.

121. *Table showing the Number of Men necessary for the Service of each Nature of Gun.*

	36 Prs.	24 Prs.	18 Prs.	12 Prs.	8 Prs.	6 Prs.	4 Prs.
Captains of Guns .	1	1	1	1	1	1	1
Privates	12	10	8	8	6	4	4
To fetch Ammunition	1	1	1	1	1	1	1
	14	12	10	10	8	6	6

The captains of guns command, and point. They are placed behind the breech. The privates, equally divided, are placed on each side, and in the following exercise are called right-men and left-men. The first man on the right spunges and rams-down cartridge. The first man on the left loads, receiving the cartridge from the powder-man, who fetches it during the action, placing himself behind the man who loads, holding the cartridge-box carefully covered.

The last, or rear-man on the right, is provided with a small apron, having a pocket to hold spare flints, and some old linen for cleaning the lock.

On board line-of-battle ships, frigates, and sloops-of-war, two gunner's-mates in each battery will be provided with bags, containing a stock and bits, four gimlets, one screw-driver, two spare locks, spare line for trigger pulls, and some old linen for cleaning the locks.

On board brigs and vessels carrying less than ten guns, one gunner carrying a bag thus provided will be sufficient.

EXERCISE OF THE GUNS.

Observations.

122. As the guns ought always to be loaded

when the ships are out of harbour, the Exercise begins according to this supposition. Upon the general command to repair to quarters being given, the powder-men proceed, in conformity with previous instructions, to the gunner's store, to fetch the powder-horns,* tube and cartridge-

* At page 54 of the French work, there is a long note on the priming of guns, of which the following is an extract:—"Priming-horns will become useless when we shall have adopted, generally, the *improved tubes.* This tube is furnished, at its upper end, with a small parchment cone, fastened by its vertex to the tube, and covered with a strong piece of parchment pasted on with a band of paper. The cone, which is about ten lines long, and about six or eight in diameter of base, envelopes the head and priming of the tube, and contains a sufficient quantity of powder to fill the pan of the lock. The parchment cover projects beyond the edge of the cone on the lower part only, to facilitate its removal in the proper direction, by tearing it up with the finger at the moment the tube is inserted in the vent, and shaking the powder into the pan." No drawing of this contrivance is given; but I have supplied one (Fig. 4. Plate III.) from the description. This method of priming is stated to be the invention of a M. Montegeny, Lieutenant de Vaisseau. It is, in principle, somewhat similar to a practice long observed in our navy, viz. attaching to each tube a common paper cartridge, containing powder sufficient to fill the pan; but, it appears to me, that the French contrivance is better calculated to preserve the powder, keep it dry, and ensure the communication of fire to the tube; for the head of the tube being contained in the cone, and its interior space open towards the lock, but covered from rain, and

boxes, &c. The two last men on the right fetch the locks, and every article with which they ought to be provided. The other men repair to their respective guns; dispose every implement ready for action; cast loose the guns, and remove every obstacle that might impede their manœuvre. The train-tackles are hooked to the cruppers of the carriages, and to the ring-bolts in the rear.

Through the whole of the exercise *for instruction*, the commanding officer explains, after each word of command, the number of motions in which the manœuvre is to be done. The men listen with attention, and do not begin to execute the intended manœuvre until the word *action* be given.

Upon the signal being given that the exercise is to commence, the greatest silence must be

screened from wind, this may be considered a very ingenious, instantaneous, and certain medium of communicating fire to the charge. The man who is to insert the tube should take it in his left hand, and introduce it into the vent, till the lower part of the base of the cone come near the edge of the pan of the lock. He will then remove the cover by its projecting part, either with his right hand or the forefinger of the left; and having poured about ⅔ of the powder into the pan, push the tube home; the open bottom of the cone will then be close to the hole or notch in the side of the pan, as represented in Fig. 5. Plate III.

observed. The captain of each gun faces to the port-holes, the men on the right and left face to their guns, dressing by the two first men, and closing to the ship's side, so as to feel slightly the elbows of each other; heads up, eyes fixed on the captain of the gun, the body upright, arms hanging down, hands open, and flat upon the thighs.

FIRST COMMAND.

123. *Take out your Tompions, cast loose your Guns.*

The 1st man on the right takes out the tompion, and places it behind him, close against the ship's side. The captain of the gun, with the assistance of the men near him, casts loose the gun, secures it against the ship's side by hitching to the cascable both tackle falls,* which he then gives to the 2d men right and left to hold; he then takes off the vent-apron, and hands it to the 3d man on the right, who places it against the ship's side. *Action.*

SECOND COMMAND.

124. *Prime your Guns. (In one Motion.)*

The captain of the gun lays hold of the priming-wire with his right hand, pierces the

* See observations on this manœuvre, Note 2d. Art. 148.

cartridge, and ascertains, by moving his wrist, and by the length of the wire, whether the cartridge be home or not; he then takes a tube out of the tube-box* (which he shuts quickly), tears off the cap of the tube, and introduces it into the vent. He then takes the priming-horn in his right hand, opens the pan of the lock with his left, fills it with powder, shuts it quickly, and replaces the priming-horn behind him. *Action.*

THIRD COMMAND.

125. *Point your Guns. (In three Motions.)*

1st Motion.—The captain of the gun places himself to the right of the train tackle, his left foot advanced and flat on the deck, the knee bent; his right leg stretched backwards, his left hand laid on the base-ring of the gun, and his right hand on the handle of the pointing-wedge or quoin. The 3d man, assisted by the 4th for heavy guns, takes up the hand-spike and the iron crows, places them upon the steps of the carriage to raise or lower the breech, as the captain of the gun may direct, until the gun have a proper degree of elevation.† *Action.*

* See observations on this manœuvre, Note 3d. Art. 148.

† Detailed instructions for pointing are given in Note 4th. Art. 148.

2d Motion.—The same men then place the hand-spikes and crows under the cheeks of the carriage, to traverse the gun to the right or left, loosening the tackle-falls, and handing them to the men placed nearest to them, who, with the assistance of those who are not employed in pointing or traversing, keep the gun hauled taught to the port. The captain of the gun then cocks the lock, takes hold of the trigger-line in his right hand, and falls back, quickly, beyond the recoil of the gun. He points. stooping and placing his eye in a line with the chace-sight and the breech-ring. *Action.*

3d Motion. —The gun being pointed, the captain gives the command—*To your posts.* Upon which the men withdraw the hand-spikes and crows, and fall-in, holding them upright, resting on the deck, so that the trucks may not run over them when the gun recoils. *Action.*

FOURTH COMMAND.

126. *Make ready with the Lint-stock. (In One Motion.)*

The rear man on the left lays hold of the lower end of the lint-stock with his right hand, and of the top with his left, places himself on a line with the hind-axletree, facing the port-hole,

stoops, in order to blow upon the match, then holds it within four inches of the base-ring of the gun, ready to fire the moment the captain of the gun gives the word, if the lock should fail. *Action.*

FIFTH COMMAND.

127. *Fire. (In two Motions.)*

1st Motion.—If the pointing of the gun with respect to *line* be correct, the captain watches for the favourable time to fire.*—The moment it offers, he makes it known by a signal; and pulls, with a jerk, the trigger-line. If the gun should not go off, and he think the direction still good, he will give the command, *fire,* the moment the roll of the ship allows it. Upon this the man sets fire to the tube with the lint-stock, holding it so as not to be higher than the vent; he withdraws it quickly, and refixes it in its place the moment the gun has gone off.

Upon the signal to fire, the men who have hold of the tackle-falls let them go, taking care that they are not in the direction of the trucks. The men holding the hand-spikes and crows lay them on the deck. Every man, except the

* Detailed instructions for pointing and firing are given in Notes 4th and 5th, Art. 148.

first right and left, move quickly to the train-tackle, hook it to the crupper,* and haul upon it if the gun should not have run in sufficiently. The first man on the right lays hold of the iron crow by the claw end, to block the trucks, as soon as the gun is clear of the port-hole—the same man, together with the 1st on the left, clears the tackle-falls and breeching; and the last man on the left fastens the train-tackle-fall with a clove-hitch. *Action.*

2d Motion.—The 3d man right and left, with the assistance of the 4th for heavy guns, lay hold of the hand-spikes and crows, place them under the breech, and heave it according as they are directed by the captain of the gun, who adjusts the bed and quoin so as to replace the gun in a position convenient for being loaded. The other men clear the side and train-tackle-falls. The hand-spike is put back into its place, the crow laid across the truck, and every man falls into his place. *Action.*

SIXTH COMMAND.

128. *Stop the Vent, spunge your Guns. (In two Motions.)*

1st Motion.—The captain of the gun takes

* The reason for not keeping the train-tackle always hooked is given in the fourth paragraph of Note 5th, Art. 148.

the priming-wire in his right hand, and enters it into the vent to ascertain if it be clear,* he then stops it with the thumb of his left-hand until the gun be loaded. The first man on the right places himself by the muzzle, stepping over the tackles and breeching, and the second man hands to him the spunge, which he immediately rams down to the bottom of the cylinder. *Action.*

2d Motion.—The 1st man on the right having rammed down the spunge to the bottom of the bore, twists it round several times; and, as in using the worm, draws it out, still turning it in the same direction; he then lays it on the muzzle, and strikes it three or four times to shake off any remnants of the cartridge or foulness.

The captain of the gun introduces the priming-wire into the vent, to ascertain that it is clear, and then stops it; the last man on the right cleans, in the mean time, the lock, half cocks it, and falls back to his post. *Action.*

SEVENTH COMMAND.

129. *Prepare to load. (In one Motion.)*

The 1st man returns the spunge to the 2d, and receives from him the rammer, the head of

* See directions for clearing the vent, Note 6th, Art. 148.

which he rests on the head of the carriage, holding the handle with both hands. With light guns the spunge-stave is turned, as the spunge and rammer are upon the same handle. *Action.*

EIGHTH COMMAND.

130. *Load with Cartridge. (In one Motion.)*

The 1st man on the left faces to the left, to receive from the powder-man the cartridge, which must be carefully put in with the bottom first, and the seam downwards.* The 2d man takes a wad, hands it to the 1st, who places it over the cartridge. The 1st man on the right stretches out his right arm at full length, resting his left hand on the muzzle of the gun, his body inclined a little forward, ready to ram down. The moment the provider has delivered his cartridge, he goes for another, holding the cartridge-box under his left arm, and his right hand on the lid. *Action.*

NINTH COMMAND.

131. *Ram down Cartridge. (In one Motion.)*

The 1st man on the right rams down three

* If the charge is not for immediate use, the directions given in Note 7th, Art. 148, will be observed.

times,* then lets go the rammer, drawing back his body. The captain of the gun introduces the priming-wire into the vent, to ascertain if the cartridge be home; if it is not, he gives the command to ram down a second time. When he finds all right, he gives a signal with his hand, upon which the man draws out the rammer, and places the head of it on the fore-part of the carriage as before. In the mean time, the 2d man on the left takes up a shot, which he hands to the 1st man, and immediately afterwards a wad. *Action.*

TENTH COMMAND.

132. *Shot and Wad your Gun. (One Motion.)*

The 1st man on the left puts the shot into the gun,† and, to prevent it from falling out, places his right hand upon the muzzle; with his left he takes the wad, which is handed to him by the 2d man, and places it over the shot. The 1st man on the right then thrusts them down with the rammer, and, ascertaining by the length of the handle that they are home, in-

* In case of a heavy sea, observe the directions given in Note 8th, Art. 148.

† Observations upon the application of double charges of shot, are given in Note 4th, paragraph 4, Art. 148; and in Note 9th, Art. 148.

forms the captain of the gun of it; then stretching his right arm at full length, rests his left hand on the muzzle of the gun, and inclines his body forward, ready to ram down. The 1st and 2d men on the left fall back to their posts. *Action.*

ELEVENTH COMMAND.

133. *Ram down Shot.* *(In one Motion.)*

The 1st man on the right rams down twice, draws out the rammer, and delivers it to the 2d man, who lays it down on the deck. If it is a light gun, he turns the stave. The 1st and 2d men on the right fall back to their posts. *Action.*

TWELFTH COMMAND.

134. *Run out your Guns.* *(In two Motions.)*

1st Motion.—The 1st man on the right unblocks the trucks, by removing the iron crow, and puts it back in its place; then, with the 1st man on the left, lifts the breeching to prevent it from getting foul during the operation. The rear-man on the left loosens the clove-hitch on the train-tackle, keeping hold of the fall, to slacken it as the gun is run out. All the other men lay hold of the side tackles. *Action.*

2d Motion.—The captain of the gun gives the word *heave.* The men all pull together to

run out the gun square to the breast of the port; which being done, the captain takes care to secure it, by taking a turn of the tackle-falls round the neck of the cascable, giving the ends to the 2d man on each side to hold on. *Action.*

N.B. If the exercise is to be continued, it will be resumed from the second command, art. 124; if not, it will be concluded by the following command.

THIRTEENTH COMMAND.

135. *Put in your Tompions. Secure your Guns.*
(In two Motions.)

1st Motion.—The 3d man on the right hands the vent-apron to the captain of the gun, who lashes it on the breech, and then loosens the tackle-falls, and gives them to the two rear-men to hold. He then places the slack of the breeching, which is held up by the 2d man on each side, between the cheeks of the carriage, and orders the men to haul taught the side tackles, which he then fastens with a clove-hitch round the neck of the cascable. *Action.*

2d Motion.—The 1st man on the right puts the tompion into the muzzle of the gun; the other men coil up the tackle-falls, fasten the coils neatly to the cheeks of the carriage, and

put every implement in its proper place. The rear man on the left unhooks the train-tackle, and lays it on the gun. The powder-man carries back the priming-horn, tube, and cartridge-boxes, to the gunner's store. The rear man on the right carries back the bag-apron, with spare flints, &c. and the lock, unless special directions be given to leave it fixed. *Action.*

EXERCISE OF CARRONADES.

136. Number of men necessary for the service of carronades of all natures, with taught breechings.*

Captain of carronade . . .	1
Privates	2
Provider	1
	4

The captain is placed in the rear of the breech. One man on the right to spunge and ram down; the other on the left to load. The provider fetches ammunition, and takes his place behind the man on the left.

For every two carronades, a quoin is provided to replace the elevating screw in case of accident; also one hand-spike and an iron crow

* *À bragues fixes*, a non-recoil principle.

Observations.

As the ordnance should always be loaded when ships are out of harbour, the exercise begins upon the supposition that this has been observed. It is taken for granted also that the decks have been cleared for action.

Upon the general command for exercise being given, (beating to quarters,) the powder-men repair to the gunner's store-room to fetch the priming-horns, tube, and cartridge-boxes. The left men fetch the bag-aprons, with their furniture, and the locks if not already fixed. The right hand men repair to their respective pieces to get every thing ready for working them, fix the pointing-bars in their places, and see that the breechings are securely fastened.

WARNING DRUM.

The beating of the warning drum being a signal that the exercise is to commence, the greatest silence must be observed. The captains of pieces face to the port-holes, the men right and left fall into their places, closing to the ship's side; heads up, eyes directed towards the captain of the piece, the body upright, the arms hanging down, hands open, and flat upon the thighs. Upon the drum ceasing to beat, every man remains steady.

FIRST COMMAND.

137. *Take out Tompions, and clear the Vents.* *(In one Motion.)*

The man who is to charge the piece takes out the tompion, and lays it down behind him against the ship's side. The captain of the carronade takes off the apron, and lays it on the deck, in rear of the man on the right. *Action.*

SECOND COMMAND.

138. *Prime your Carronades.* *(In one Motion.)*

The captain of the piece takes hold of the priming-wire with his right hand, pierces the cartridge, and ascertains, by turning his wrist, and by the length of the wire, whether the cartridge be home or not. He then puts a tube into the vent, opens the pan, primes with powder, shuts the pan, and replaces the priming-horn in its place. *Action.*

THIRD COMMAND.

139. *Point your Carronades.* *(In two Motions.)*

1st Motion.—The captain of the carronade places himself on the right of the pointing-bar, his left foot advanced and flat on the deck, his

knee bent, his right leg stretched backward, his left hand resting on the base-ring, and his right hand on the handle of the elevating-screw. He then turns it so as to raise or lower the breech, until the piece be brought to the proper elevation. *Action.*

2d Motion.—The captain of the piece cocks the lock, lays hold of the trigger-line with his right hand, and steps quickly backward beyond the end of the pointing bar. The men traverse the piece according to the directions of the captain, who, stooping to place his eye in a line with the muzzle and breech-sights, points the carronade at the object to be aimed at. When the piece is pointed, he gives the command—*to your posts,* upon which the men resume their former places. *Action.*

FOURTH COMMAND.

140. *Make ready with the Lint-stock. (In one Motion.)*

The man on the left lays hold of the lower end of the lint-stock with his right hand, and the top of it with his left, places himself by the side of the breech, facing the port-hole; stoops to blow the match, holding it considerably lower than the vent, then advances it within

four inches of the piece, ready to fire the moment the captain gives the word, should the lock fail. *Action.*

FIFTH COMMAND.

141. *Fire. (In one Motion.)*

If the line be correct, the captain of the carronade watches for the favourable moment for firing. As soon as it offers, he makes it known by a signal with his hand, and pulls, with a smart jerk, the trigger-line. If the lock should fail, and the direction be still correct, he will give the word *fire* a second time, as soon as the position of the ship, with respect to the rolling motion, is favourable. Upon this command the man with the lint-stock sets fire to the tube, taking care not to hold his lint-stock higher than the vent. *Action.*

SIXTH COMMAND.

142. *Stop the Vent; Spunge. (In two Motions.)*

1st Motion.—The captain of the carronade ascertains, by means of the priming-wire, whether the vent be clear, and then stops it with the thumb of his left hand till the piece be loaded. The man on the right moves quickly to the muzzle, puts his body and his right leg outside of the sill of the port, resting his right

foot on a cleat fixed there for the purpose, his left foot resting on the inside. *Action.*

2d Motion.—The man on the left takes the spunge with his left hand, and hands it out to the man on the right, who takes care to thrust it down to the bottom of the *chamber*, turning it several times, and in drawing it out, keeps turning it in the same direction. The captain of the piece ascertains that the vent is clear, and then stops it, whilst the man on the left cleans the lock, half-cocks it, and falls back to his place. *Action.*

SEVENTH COMMAND.

143 *Load with Cartridge.* *(In one Motion.)*

The man on the right having spunged, hands over the spunge to the man on the left, who lays it quickly against the ship's side, and turning to the powder-man receives from him a cartridge, which he gives to the man on the right, who puts it into the piece, with the bottom first and seam underneath. The man on the left then hands the rammer to the man on the right, who introduces it into the bore, ready to ram down when ordered. The powder-man, having delivered his cartridge, goes for another, carrying his cartridge-box under his left arm, and his right hand upon the lid. *Action.*

EIGHTH COMMAND.

144 *Ram down Cartridge. (In one Motion.)*

The man on the right rams down three times, and then, drawing his body back, lets go the rammer whilst the captain uses the pricker to ascertain that the cartridge is home. If it is not, he orders the man to ram down again; if it is, the captain gives a signal, upon which the right hand man withdraws the rammer, hands it to the man on the left, who lays it down and takes up a shot. *Action.*

NINTH COMMAND.

145. *Shot and Wad your Carronades. (In one Motion.)*

The man on the left lays a shot upon the carronade, and guiding it with both hands, rolls it forward until it can be reached by the man on the right, who then puts it into the carronade, keeping his right hand on the muzzle to prevent the ball from falling out. The man on the left takes up a wad and the rammer as soon as he has delivered the shot, and hands them over to the man on the right, who takes hold of the wad with his left hand, puts it over the shot, then takes the rammer with his right hand, introduces it into the piece, and remains ready to ram down. *Action.*

TENTH COMMAND.

146. *Ram down Shot.* *(In one Motion.)*

The man on the right rams down the shot, and sets it up with two blows; ascertains, by the length of the stave, that the charge is home, informs the captain, draws out the rammer, hands it over to the man on the left, and all resume their places. *Action.*

N.B. If the exercise is to be continued, it will be repeated from the Second Command, Art. 138.; if not, it will be concluded by the following command.

ELEVENTH COMMAND.

147. *Put in Tompions.—Replace Aprons.* *(In one Motion.)*

The man on the right puts in the tompion. The captain of the carronade replaces the apron, and lashes it on; takes out the pointing-bar and sends it, as well as every other implement, to its proper place. The powder-men carry back to the gunner's store, the priming-horns, tube, and cartridge-boxes. The men on the left carry back the bag-aprons, and locks, if not intended to be left on the carronades.

Upon the beating of the warning-drum every one falls into his place, as at the beginning of the exercise, and remains steady till regularly dismissed.

148. GENERAL OBSERVATIONS.

Note 1st.—*Warning Drum.* Should there be no drum on board, the warning may be given by the command—*Prepare for Action;* and, a proper time being allowed for getting every thing ready, the warning may terminate by the word *attention.*

Note 2d.—*Take out Tompions; unlash your Guns.*—(1st Command, Art. 123.) If the ship does not heel so as to cause the guns to run in, it is unnecessary to attend to the side tackles as directed in the First Command, Art. 123; and that precaution may therefore be dispensed with in every such case. If, on the contrary, the vessel heel so much as to render it unsafe to loosen the tackle-falls from the cascable, as prescribed in the 2d Motion of the 3d Command, (Art. 125.) the captain of the gun will have them held on until the word *fire* be given; but previous to cocking the lock, he will take care to place undermost, the tackle-fall on that side of the gun towards which he foresees the breech will be thrown. If, in executing the above command, the guns are not loaded, the tackles will be slackened, to let the guns run in, as indicated in the 1st Motion of the Command *fire,* (Art. 127.) and the manœuvre will be continued according to that article.

Note 3d.—*Prime your Guns.*—(2d Command, Art. 124.) If there be neither tubes nor locks, the captain of the gun will prime with powder, using the priming-wire to ascertain that the vent is filled. He will then make a train of powder as far as he can, towards the side on which the gun is to be fired, taking hold of the priming-horn with both hands, to bruise the powder that is to be touched with the match. He will then take care to remove any powder that may be sticking to the horn.

Note 4th.—*Point your Guns.*—(3d Command, Art. 125.) No part of the exercise requires more particular attention than *pointing*. The captain, officers, and gunners should lose no opportunity, and spare no pains, in giving the most circumstantial instructions to the men on this important subject; always ascertaining the degree of correctness with which it is executed, both in school exercise and in action, whenever circumstances will admit.

The captains of guns will point higher or lower than the part intended to be hit, according to the distance of the object; they should therefore be well exercised in estimating distances.

When a gun is to be fired at an object at point-blank distance, the piece must be aimed

direct at the object.* This distance is nearly as follows,—for a 36-pounder gun or carronade, 650 metres, or 3¼ cables length.†—For 24, 18, and 12-pounder guns, 600 metres, or 3 cables length.—For 8, 6, and 4-pounder guns, and 24-pounder carronades, 500 metres or 2½ cables length. Beyond these distances the pieces will be pointed *higher* than the part intended to be hit, in proportions corresponding to the distance. At distances less than the above ranges, the pieces will be pointed *lower* than the part intended to be struck; but as, when ordnance are pointed too low, the shot produce no effect, whilst those fired too high to strike the hull may nevertheless hit the rigging, it is preferable rather to point too high, than aim too low.

In using two projectiles from the same gun, it should be pointed higher in a proportion necessary to compensate for the reduction of range occasioned by the double weight. Two round shot should not be used at a greater distance than 800 metres, or four cables length.‡

* The French point-blank is what we call the line-of-metal. Hence great complication in regulating the practice according to the method described in the text.

† The length of a French cable, reduced to English feet, is 639 feet.

‡ 852 yards.

Bar-shot, or grape-shot, should not be used at a greater distance than 400 metres or two cables length.

If the ship heels in the least, which is almost ever the case when under sail, the captain of the gun will first point it horizontally, at the moment the vessel comes on an even keel, or arrives at the middle of her rolling motion. In this position a line of sight over the gun will pass and repass the object intended to be hit; and the captain of the piece must exert all his intelligence to catch the precise moment for firing, anticipating so that the shot may take effect when the object arrives in the line of direction.

The guns ought never to be fired when the ship rolls to the side which is in action, but always when that side rises; because, in the rising motion, the shot which miss the hull may take effect in the masts or rigging.

When a vessel is to pass rapidly by the object that is to be fired at, or when another vessel is to move rapidly past her, the guns should not be traversed fore and aft, to anticipate the object, but should be pointed square in the ports; and the captains instructed to wait until the mark come in the direction of their guns, and then to fire with the greatest precision, by paying

attention to the rolling motion, as well as to the arrival of the object in the proper line. A very oblique fire is very uncertain; it strains the ship's sides, the shot hit with less force, and meet with more resistance.

Should it be necessary to point carronades higher than the elevating-screw will allow, it must be taken off, and the quoin used.

Note 5th.—*Fire.*—(5th Command, Art. 127.) Should a piece burn-priming, it should not be immediately approached; when no more smoke comes out of the vent, the captain of the piece, and the man who carries the bag provided with old linen, &c. step up to the breech,—the former to clear the vent, prime and cock the lock,—the other to clean it.

The captain of the piece re-examines the direction, and rectifies it if necessary; acting according to what is prescribed in the 1st Motion of the 5th Command, *Fire*, Art. 127.

When, from a deficiency of locks, it is necessary to resort to the lint-stock, tubes should nevertheless be used as long as there are any.

When, from the position of the ship at the moment of firing, there is reason to apprehend that the recoil will be rapid and violent, the train-tackle should be unhooked; for it will be difficult to take in the slack of the fall fast

enough to prevent the block from being injured by the carriage, and the tackle from getting foul; but it should be hooked on again as soon as the gun has run in.

Note 6th.—*Stop the Vent; Spunge.*—(6th Command, Art. 128.) If the vent should get stopped, and the captain should not succeed in clearing it, he will make the circumstance known to the officer nearest to him, who will have it cleared by the gunner's mates, who, provided with bags of tools for such purposes, are always stationed in the battery.

Note 7th.—*Load with Cartridge.*—(8th Command, Art. 130.) When a gun is loaded, but not with the intention of being fired immediately, a wad is always put over the powder, observing to fix it with a bit of rope-yarn to the neck of the cartridge, in order that it may be drawn out along with the wad, should it be necessary to draw the charge.

Note 8th.—*Ram down Cartridge.*—(9th Command, Art. 131.) When the sea is so rough as to render it necessary to shut the lower-deck port as soon as the gun has run in, the muzzle must be raised in a direction towards the light-port, or scuttle, in order to run the handle of the spunge, or rammer, through it, and by this expedient be able to load the

gun. But if the enemy's ship be so close as to prevent the use of wooden or stave spunges, rope handles, having the spunge at one end and the rammer at the other, must be substituted.

Note 9th.—*Shot and Wad your Guns.*—(10th Command, Art. 132.) The guns should never be loaded with more than one projectile, but by special orders from the officer commanding in the battery. When this is done, the double load may either consist of two round shot, or one bar and one round-shot, or one grape and one round. (Note 4. Art. 148.) In the latter case, the round-shot must always be put in last, because it will have much greater velocity than either of the others, and would strike them so violently as either to occasion fractures or to alter the direction.

Carronades should never be fired with more than one projectile.

ENGAGING ON BOTH SIDES; AND SHIFTING SIDES IN ACTION.

149. It is supposed that the priming-horns and tube-boxes are hung upon the cascables of the guns on that side of the ship on which the exercise is not performed, and that every article and implement belonging to the guns has been

placed according to what has been prescribed for *clearing for action.*

The service of the starboard battery is done by the men belonging to the odd number of guns, reckoning from head to stern; and the service of the larboard side done by the men belonging to the even number of guns. When both batteries are manned, the people belonging to each gun serve that piece and the next on its right.

When the command is given for engaging on both sides, the officers and gunners will never fail to remind the captains of guns whether they are to remain where they are, or to shift to the opposite side.

COMMAND.

150. *Make ready for Action on both Sides.*

The men fix their eyes on the captain of their gun, and wait for his signal whether they are to go on with the manœuvre of their own gun, or to be detached to the adjoining piece, or to shift to the other side. If the ship has been engaged on the starboard side, the captains of guns, Nos. 1, 3, 5, 7, 9, 11, &c. reckoning from the head, are at their posts; and those of guns, Nos. 2, 4, 6, 8, 10, with their crews, shift to the corresponding pieces on the larboard side.

If the ship has been engaged on the larboard side, the captains of guns, Nos. 2, 4, 6, 8, 10, &c. reckoning from the head, are at their posts; and those of guns, Nos. 1, 3, 5, 7, 9, &c. with their crews, shift to the corresponding pieces on the starboard side.

The captains who are to remain at their posts, detach from their pieces to those adjoining on their right, the men who have acted as chargers (2d captains) of their own, and also the 2d and 3d right-side men; observing, however, that if the charging of any gun has been commenced, its captain will not give the word of command for executing this movement, until his gun be reloaded.

The three men thus detached to each of the guns that have been left by the people now manning the other battery, will remain attached to those pieces so long as the ship is engaged on both sides. The men who were chargers become captains, and will receive the priming-horns and tube-boxes from the captains who are to shift to the other side. The 2d right man, brought from the adjoining gun, becomes the charger—the 3d the powder-man. And the corresponding duties are performed at the gun they have left, by the captain and his 1st and 2d left-men.

The captains of the guns who are to shift to

the other side, will take care to belay their gun tackles, before they give the signal for executing this movement, and to finish the operation of loading, should it have been commenced. They will, at all events, not move until relieved by the men who are to replace them as captains, to whom they will deliver the priming-horns and tube-boxes, and report whether the gun is loaded or not.

Upon the signal to move being given, the captains who are to shift, will, with their three left-hand men, pass to the corresponding guns on the opposite side; detaching their three right hand men to the gun next adjoining on the right. The duties of the men thus posted will be the same as for the service of the corresponding guns on the side they have left. The captains, and chargers who are to become captains of alternate guns, will immediately take charge of the priming-horns and tube-boxes, which they will find hanging on the cascables of the pieces.

Should there be an odd number of guns on the broadside battery, the men belonging to the aftermost piece will work it and the opposite gun, in the same manner as has been directed for the service of two contiguous pieces by one gun-crew.

The complement of men for 8-pounders and under, as well as for carronades, not being sufficiently numerous to admit of dividing their crews, only half the pieces can be served in fighting both sides. If in such a case, it be important that the lines of fire be contiguous, for the purpose of concentrating the effect, the crews will close up, either fore or aft, as may be necessary, so as to leave no piece in inactivity, between any two that are manned.

151. The men being at their posts on both sides, according to the preceding directions, if it should become necessary to man one side only, the word of command is given accordingly—*All gunners to starboard, or larboard.*

The captains, and acting captains of guns on the side named, go on with their service; those on the other side will see that all the guns are re-loaded, put on the aprons, secure the guns on the lower deck from running-out, by blocking the trucks with the iron crow-bars and by casting a clove-hitch on the train-tackles, and shut the ports if necessary. The guns on the other decks are run out, and the side tackles belayed. The priming-horns and tube-boxes hung upon the cascables. On the signal being given, the acting captains and their men return to their proper guns, and thence the complete

crews pass to the corresponding pieces on the other side.

Observation.

What has now been said relates to the measures to be taken when a ship, engaged on one side, is obliged to continue the engagement on both sides, and thence to resume action with one battery; but there remains another case to be considered, viz. when, having been engaged on one side, the men are all to be shifted to the other. For this purpose the command is—

152. *Make ready for Action on the other Side.*

The guns on the lower deck, whether loaded or not, will be secured at the extent of their recoil, and the ports shut if necessary. The captains of those pieces that are loaded will immediately shift, with their crews, to the corresponding pieces on the other side. Those that are not loaded will be charged by the 1st, 2d and 3d right-hand men, according to the instructions given for engaging on both sides; and as soon as this is done, they will join their proper guns on the other side.

The same will be observed on the upper decks, taking care to secure the guns that are run out, by belaying the gun-tackles.

The captains of guns will place the vent-aprons on their pieces as soon as they are

loaded; and leave the priming-horns and tube-boxes hanging on the cascables of the guns that are left.

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153. SHIFTING A GUN FROM ONE CARRIAGE TO ANOTHER.

This may be done in several different ways, which we shall explain, in order that the most advantageous mode may be resorted to, in cases of necessity, according to the means at command, and the position of the gun.

First Method.—By means of the apparatus called *tackling for mounting and dismounting guns*. This consists of—

Two gun-strops (*a*)* having a single block at each end.

Two strops (*b*) with a single block at one end.

Four runners, (*c*) suited to the weight of the gun, each having a thimble at one end, and the other pointed.

Two ring-bolts (*d*) placed in the carriage†

* These references are used to aid the following description of the manœuvre.

† In the original, it is directed that ring-bolts be fixed in the *barrot*. The barrot is a beam of about half the thickness of the ordinary deck beams, placed in the centre of the interval, between every two. As there is no such piece of timber in

over the gun, one at about three feet, the other at about nine feet from the ship's side.

The gun being placed with its chace under one of the ring-bolts (*d*), and its breech under the other, a strop (*b*) is reaved through each ring, and another single block fastened on.

The two gun-strops (*a*) are then fastened round the gun in clove hitches, one round the chace, the other round the breech, and in such a manner as to bring the four blocks (two on each side of the gun,) to the same level. A runner (*c*) is then reaved through each of the four blocks attached to the rings above, then through the corresponding blocks attached to the gun, and the pointed ends fastened to the ring-bolts above, the runner being first hauled through sufficiently to bring the four thimbles in the ends of the four runners close to the upper blocks. The double blocks of four gun-tackles are then hooked to the thimbles of the four runners, and the other blocks of the tackles hooked on to any convenient ring-bolts in the deck. The cape-squares, or trunnion clamps, are then taken off, or opened, and the four

English ships, I have substituted for it *the carlings*, which are made much stronger in our vessels than in French ships.

tackles manned. At the word *heave*, the men pull together, when the gun is soon raised sufficiently to admit of withdrawing the carriage, and introducing another. This manœuvre requires the crews of two guns; but it is the safest that can be used for heavy pieces, and should always be preferred when there is much motion.

Second Method.—The muzzle of the gun is strongly secured to the housing-ring by the chace-rope-band; the bight of a strong rope is then thrown round the neck of the cascable, and both ends reaved through the ring-bolts in the carlings above. The cape-squares are then removed; two strong levers placed under the cascable, or breech, to raise the piece, making use of any convenient part of the carriage as a fulcrum. In proportion as the breech is raised, the rope is hauled through the ring above, and held on, whilst the levers are fetching fresh purchase. When the gun is raised sufficiently to clear the carriage, it is removed.

Third Method.—When the gun to be shifted is on the gangway, quarter-deck, or forecastle, it should be removed under one of the winding, or yard-tackles, by which it will very easily be lifted, and lowered down again.

Fourth Method.—If the carriage be broken, and the gun (dismounted) be so situated that

neither of the preceding methods can be used, it must be placed on the deck on two skids, with the vent underneath. The new carriage, without its trucks, is then placed, inverted, upon the gun, and the trunnions secured in the trunnion-holes by fore-locking the cape-squares. The gun and carriage are then firmly lashed together by two strong par-buckles, passed round several times, one round the bend or arch of the carriage, the other a little a-head of the front axle-tree, and both leading off in the direction in which it is intended to right the gun. A lever is put into the bore of the piece to assist in the operation. The par-buckles being well manned, the piece is raised by degrees; but as soon as the ends of the axle-trees touch the deck, wedges must be nailed on, to prevent their slipping. Additional ropes must also be used to ease the motion, and to prevent the carriage from coming over with violence upon the deck.* The trucks are easily put on, as soon as the carriage is righted.

154. When, owing to drafts made from gun-crews, to increase musketry-fire, to assist in working the ship, to board, or in case of fire, the

* This is a very simple and excellent method of mounting guns, on shore at least. I have frequently seen it practised with great rapidity and success.

number of men is reduced to one half, or thereabouts, of the hands required to work all the guns, (leaving, consequently, too few to man all the battery,) the private men belonging to two adjoining pieces will be united, and pass, alternately, from one gun to another, observing however that the captains and chargers remain at their proper pieces. The command for this manœuvre is,—*Double up to the right, or left.* If to the right, the captain of the left gun orders all his men, with the exception of his charger, to pass to the piece on the right, and so on, for every two guns. If to the left, the movement begins at the furthermost gun on the right; but in either case, the captain takes from his last right-man, the bag containing spare flints, linen, &c. and charges himself with his duties.

If further drafts be made from the batteries, and there should not remain more than one-third, or one-fourth of the men for the guns, the crews of three or four pieces must be united, to serve one gun at a time. In this case, it must be specified upon which gun-crew, and under what captain, the men are to form. When four or five incomplete complements of men are to serve eight or ten pieces, neither the captains nor chargers are to remain at their proper guns; but all serve as privates under the captain

named in the order; and consequently pass with him from one gun to another.

REGULATIONS FOR THE GUN EXERCISE.

155. All naval officers, midshipmen, and master-gunners,* should be qualified to direct the exercise for every nature of ordnance, and explain all the details.

For this purpose, each officer will be charged with the particular instruction of a certain num-

* In the French service, the crew are first instructed by the gunner (le maître canonnier), assisted by his first mate (capitaine d'armes) and others of his crew (aides canonniers). These men are all regularly trained in the art of gunnery, and are consequently well qualified to discharge this important duty.

Besides the establishment which furnished these most useful functionaries, there was formerly, (and it either has been, or will be revived,) at each naval station, a body of young seamen, called *apprentifs-canonniers*, regularly trained to gunnery, a certain number of whom always formed part of every ship's crew. The suspension of such establishments during the war, is quite sufficient to account for the wretched condition of the French naval practice towards the close of their maritime operations, as already noticed, page 2. The work, of which the text contained in this part is a Precis, provides for the revival of all the useful parts of their former system; and the vast utility of that just noticed, is too obvious to be overlooked, either by them or by others. Let the reader consider this, relatively with what he has read in Part I.; particularly referring to Note, p. 18.

ber of guns, in proportion to the number of officers.

A proportion of midshipmen will be attached to each officer, to command, under his superintendence, the different manœuvres of a gun.

Every captain of a ship will, as soon as possible after she is manned, assemble the chiefs of the guns, and their chargers,* and forming them into as many complete squads as they can furnish, exercise them, twice a day, until they are perfect in every duty about a gun.

The seamen will then be drilled, twice a day, by the chiefs already trained, one of whom will be attached to each gun, and held responsible for the advancement and correct application of the instruction, and for the perfect execution of every motion and manœuvre.

Besides the exercise prescribed in the preceding articles, the chiefs, chargers, and privates, will be instructed in the names and objects of the different parts of a gun and carriage; also of the tackling, utensils, and ammunition: after which they will be exercised in the various cases applicable to real service.

In the general exercise of a side, or deck, officers will be called, in succession, to take

* Our first and second captains of guns.

command; so that each may be perfectly qualified to execute this important trust.

PRACTICE.

156. In every sea-port that can admit of it, a butt will be erected in such a situation as to admit of ships practising against it, either at anchor or under sail.

In any port, or naval establishment, where a butt cannot conveniently be established on shore, *floating butts* will be provided for ships to practise against, both at anchor and under sail: these floating bodies will be placed, if possible, so that the shot may either fall on dry land, or be found on the beach at low water.

The practice will not commence until the men are fully instructed in the exercise; and their judgment formed to the important means of acquiring accuracy in pointing and firing; first using tubes and priming, and then blank-cartridges.

The Gun Exercise and Practice are divided into two classes. The first to commence immediately after the ship is put in commission, in order to *form* the crews; the second, to keep them perfect.

After every lesson in the practice, the officer charged with the instruction will make a written

report, in which he will distinguish the most expert chiefs, forming them into two classes; and at the end of every month, pecuniary rewards will be paid to the most proficient, in certain proportions,* by the officer commanding the naval station, or by the prefet of the department.

It will not be disputed, that the provisions contained in the Règlement of which I have given a translation, ensure vast improvement to the French Marine, if they are strictly observed; and I do not doubt that whoever studies the preceding code attentively, and fully considers its tendencies, will perceive additional reasons for attempting something in the same way ourselves.—If the reader think so, let me refer him again to Part I. which was written long before I had heard of the measures which the French have adopted.

* Twenty francs are paid to the chiefs named in the first class; and ten francs to those recommended in the second. Of these prizes, four of each are allowed after each lesson in ball-practice in three-deckers; three in two-deckers; two in frigates; and one in sloops or brigs.

Although some parts of this manual are inapplicable to our service, yet the system is excellent, in principle, in many respects; and in none more so than in the exact and minute repetition of every little detail, and of every movement. This may be regarded by some persons, as partaking too much of the soldier-system of smartness, and uniformity of appearance; but those who have had much experience in the different modes of training people to military exercises afloat, know well, that every separate motion being constantly repeated, will give that mechanical habit of executing it, which will ensure the correct performance on actual service, when the whole movement is to be comprised under one word of command. There is so much to consider in working naval ordnance—so much attention required to tackles and breechings—so many precautions necessary to protect the priming from sea-spray, and screen it from strong wind—that every detail must be impressed strongly on the gunners' memories, and their practice at their guns made as mechanical as the manual exercise of a regiment of soldiers. To form and establish these mechanical habits, the French practice of making the exercising officer

repeat and explain the details of every motion, before it is commenced, is excellent.—It proves the knowledge of the instructor, keeps his attention alive to the most minute details; and, by frequent repetition, must give every man a mechanical habit of doing right, which is the only security against confusion in a real affair.

PART IV.

ON THE EQUIPMENT, PRACTICE, AND SERVICE OF NAVAL ORDNANCE.

157. Great errors in the practice of Gunnery arise from those diminutions in the strength of powder, which invariably result from any absorption of moisture. Naval ammunition, being particularly liable to be thus injured, should be protected with special care and precaution from the influence of those pernicious damps to which it is continually exposed.

The only effectual method of doing this, is to keep the ammunition in close vessels, with air-tight covers. Copper cases have recently been manufactured in the Royal Laboratory for this important purpose; and no expense should be spared in providing a supply of these vessels sufficient for a state of war; for so long as gunpowder is exposed to suffer great and unknown losses of strength, all attempts to attain much accuracy in practice, will, in all cases of protracted service, be defeated.

158. No degree of care, however, can alto-

gether preserve naval ammunition from receiving some degree of injury, by exposure to marine damps; because a quantity sufficient for immediate use must always be kept ready for serving out, and consequently unpacked from the close vessels; and in the exigencies of service in remote regions, ammunition of doubtful quality may be procured from stations which may not have been recently supplied; or it may be necessary to use powder obtained from the capture of enemy's magazines or vessels. It would appear, therefore, to be desirable that vessels, sent on distant and protracted service, should be provided with means by which to ascertain the condition and strength of their ammunition; otherwise ships that may have been stored abroad, or long at sea without having their powder examined and tried by competent persons, at ordnance stations, may be exposed to go into action with ammunition, apparently in good condition, but so deteriorated in strength, as to produce very disastrous consequences. This, it may fairly be suspected, has very frequently occurred; perhaps much more frequently and seriously than we are altogether aware of. It must indeed have been from such circumstances, that so many assertions have been made at different times, ascrib-

ing an inferior degree of strength to our powder, which, on the contrary, we know to be considerably stronger than that of any other nation.

159. If the condition and strength of naval ammunition were to be ascertained, by actual experiment, from time to time, by the proper authorities in the ship to which it belongs, commanders would no longer be exposed to make the mortifying discovery of the weakness of their ammunition, in the important moment of service-practice. Provided with the means of doing this previously, officers would either be enabled to report the damaged or unserviceable state of their gunpowder; or, knowing its condition, endeavour to procure a supply of better quality, if their own could not be restored to serviceable efficiency, by drying. It is requisite, therefore, that naval officers, and particularly master-gunners of ships, should be qualified to judge correctly of the condition of their gunpowder by inspection, and be taught to conduct those experiments by which its strength may be ascertained. For these important reasons, instruction on this subject should be considered indispensable in the course of training that should be established in the depots of naval gunners.

160. The only infallible test of the goodness

of gunpowder is, unquestionably, experiment: but there are certain properties by which an estimate of its quality may be formed.

Good gunpowder should be of uniform colour, approaching to that of a slate. The particles should be perfectly granulated, and free from cohesion. It should admit of being readily poured from one vessel into another; otherwise it may be concluded, either that the powder has been imperfectly glazed, or that it is damp. Good powder should be devoid of smell. If it have a disagreeable odour, it may arise from a practice which, I have been informed, is not uncommon, viz. heating the nitre excessively, for the purpose of drying it the more effectually. By this process a portion of the nitre may be decomposed; if so, potash, instead of nitrate of potash, will form a part of the powder. Now this admixture would produce several bad effects. It would diminish the proportion of nitre:—it might occasion the formation of sulphuret of potash, which would be indicated by the offensive smell of sulphuretted hydrogen. In this case, the powder would easily become damp; for potash is a very deliquescent substance. To determine whether this be the case or not, dissolve some of the powder in pure or rain water, and add a solution of silver to that

of the powder. If a black precipitate be formed, it may be concluded that sulphuret of potash existed in the powder.

It is possible, however, that the nitre may have been partly decomposed by having been over-heated, and consequently that the powder will be liable to become damp, from the deliquescent nature of the potash, although no sulphuret of potash may have been formed. In this case, the clear solution of gunpowder will turn vegetable colours brown, or the juice of violets, or infusion of red cabbage, to a green.

Powder will very readily attract moisture from the air, if manufactured with nitre containing deliquescent salts, such as common salt: if this be the case, a solution of silver, added to one of the powder, in pure water, will give a white curdly precipitate. If an impurity of this nature be found to exist; or if powder, though originally composed of well purified ingredients, should once become so damp, from the influence of sea water, as to increase its weight beyond the quantity allowed in the proof (163), no dependance can be placed on the quality of the powder; for sea water contains so large a quantity of deliquescent salt, that, as in the preceding case, although the powder may frequently be dried, and sometimes appear not to be damp,

yet it will re-attract moisture from a moist atmosphere, as often as exposed to it.

In powder which has become damp, large lumps are formed. If the injury be not very considerable, these concretions may be reduced, by drying, rubbing, and loosening; but gunpowder thus affected, never altogether regains its lost force.

Dampness in powder of good manufacture does not, in general, arise, as is commonly supposed, from the nitre attracting moisture. Pure nitre is not in the slightest degree deliquescent, it is not even hygrometrical; whereas charcoal, particularly when newly made, imbibes aqueous vapour with such avidity, that a piece of perfectly dry charcoal, exposed to the action of the air for a week, will increase in weight about 14 or 15 per cent. and the matter absorbed consists principally of aqueous vapour. Thus powder of the best quality is liable to become damp, from a circumstance which cannot be prevented by any degree of care in preparing the ingredients, and which can only be avoided by effectually excluding the atmospheric air. I have thought it right to state these circumstances, for the purpose of showing the members of the profession the vast importance of a general adoption of air-tight vessels for stowing naval ammunition; and

take occasion to add, that they should be introduced by degrees into all powder magazines.

161. It will not, in general,—perhaps never,—fall to the share of naval characters to restore damaged gunpowder, by drying it in large quantities, by artificial heat; it may, however, become necessary for them to do so. But whatever be the improbabilities of naval officers or gunners being called upon to superintend or conduct such a process, it is proper they should know the precautions that should be observed.

In drying gunpowder that may have become damp, great care should be taken to regulate properly the degree of heat applied to the process; for there are several temperatures, considerably less than that required to explode the mixture, which are nevertheless capable of injuring it extremely. If the heat to which it is exposed be above 140 degrees of Farenheit, the sulphur will begin to rise in vapour. At about 240 of Farenheit the sulphur will melt, without igniting the nitre,—the uniformity of the granulation will then be destroyed, and a number of small knotty lumps formed. These effects upon the sulphur may easily be shown, by scattering a few grains of gunpowder upon a plate of metal, heated unequally. The grains that fall upon parts much heated, will instantly explode. In

other parts the small, blue, lambent flame of the sulphur will be seen to rise and subside, without exploding the mixture. A still less degree of heat will cause the sulphur to melt; and a certain inferior degree of temperature will cause it to volatilize.

The degree of heat used in the stoves for drying gunpowder, should not, therefore, be above 140° of Farenheit.

When gunpowder has become utterly unfit for service, the nitre may be separated by putting it into vessels containing water, by which the nitre will be readily dissolved, and may then be crystallized by evaporation.

162. The strength of gunpowder has been so much increased of late years, that Tables of Ranges, formed before the commencement of the last war, are no longer considered correct rules for practice. This improvement in the strength of ammunition, is principally owing to the process of charring wood for the manufacture of gunpowder, in iron cylinders,—hence the term *cylinder powder*. The wood, properly seasoned and prepared, is put into cast-iron cylinders, placed horizontally over stoves, and the front openings closely stopped. Heat then is applied; when the pyrolignous acid, and a large portion of carbonated hydrogen gas come over, through

tubes inserted in the back parts of the vessels. The gas is suffered to escape—the acid liquor collected in casks—and the carbon left pure in the iron retorts.

PROOFS OF GUNPOWDER.

163. Lay a drachm or two of powder on a piece of clean writing paper, and fire the heap by means of a red-hot iron wire: if the flame ascend quickly, with a good report, leaving the paper free from white specks, and do not burn it into holes, the goodness of the ingredients, and proper manufacture of the powder, may be safely inferred.*

When good gunpowder is blasted upon a clean plate of copper, no tracks of foulness should be left.

Gunpowder exposed for seventeen or eighteen days to the influence of the atmosphere, should not increase materially in weight. One hundred pounds of powder should not absorb more than 12*oz.* If it increase in weight more than 1 per cent. it is a proof that deliquescent salt abounds in a degree which should warrant the condemnation of the powder.

* Observations on the Manufacture and Proofs of Gunpowder, by R. Coleman, of the Royal Powder Mills.

A musket charged with 4 *drams* of fine grained, or musket powder, should drive a steel bullet through 15 or 16 half-inch elm boards, placed ¾ of an inch from each other, the first board being set at forty inches from the muzzle of the barrel; but with restoved gunpowder the ball will only perforate from nine to twelve of the boards.

The best *cylinder* powder should project an iron ball of 64*lb.* to the distance of 180 feet, from an Eprouvette mortar, with a charge of two ounces of powder, at 45° of elevation. Powder made of common *pit-charcoal*, will only project such a ball, under the same circumstances, 150 feet. Powder that has been restoved will only produce a range of from 107 to 117 feet, under like circumstances. These facts show the vast reductions in force, and the great loss of accuracy, which invariably and irremediably attend any alteration in that perfect proof condition of gunpowder, upon which all our rules for practice are formed.

But the proofs of gunpowder by range, in the manner just stated, require means which can only be found at the principal ordnance arsenals in England, and cannot be resorted to by the Navy on most foreign stations, nor always indeed on home service. It cannot, there-

fore, but be extremely useful to point out an ingenious instrument, (the vibrating Éprouvette,) by means of which the proof of powder may be made afloat in harbour; or very readily and accurately performed anywhere on shore.

The principle of this machine is very simple: it consists of a small gun, suspended on an axis like a pendulum, from the vibration of which, when fired with a small charge, the quality or strength of the powder may easily be determined.

The idea of a vibrating Eprouvette was first started by the celebrated Mr. Robins; but Dr. Hutton, in adopting the principle, has very much improved the construction.

A brass gun, AB, Fig. 1. Plate IV. is suspended by steel rods, C, D, so as to vibrate upon the point E. A brass quadrant, F G, is attached to the rods, C, D, having an index, H E, fitted, rather tight, to the arch: the limb, E L, attached to the index, prevents it from moving in the direction of the recoil, and consequently makes it slide upon the quadrant during that motion of the gun. The pressure of the index upon the quadrant is such that, without being sufficient to check the recoil, the index may keep the place to which it has been moved, and thus show the magnitude of the greatest vibration.

To practise with the Eprouvette, charge it with a small quantity of loose powder, by means of a ladle. Raise the muzzle, by pushing the piece forward, and press the powder lightly together with a rammer head. Then set the index, by pressing the limb, E L, to contact with the head of the frame, and note the division pointed out. The piece should be primed with a thread of quick-match, and fired by a portfire. After the Eprouvette has made, freely, its first recoil, the vibrations should be gradually stopped, taking care not to touch the index, or its limb: the division pointed out on the quadrant will then show the effect of the charge; and the strength of the powder may be estimated by comparing the vibration with that which is known to be due to powder of proof strength.

ON LOCKS FOR NAVAL ORDNANCE.

164. The application of locks to the service of Naval Ordnance, is one of those improvements that were introduced into the Naval service by my honoured Father.

So long as the use of this invention was peculiar to the British marine, it operated exclusively in our favour, and produced, as is well

known, very happy results: but the advantages of such instruments having long since been so publicly exhibited as to have led other nations to adopt them, it becomes a matter of importance to us, and to me a matter of filial interest and obligation also, to see if we can procure for ourselves some exclusive advantage from the invention, by endeavouring to remedy those objections which were long and stoutly opposed to the original measure, (and some of which still exist,) and by trying to improve the construction and workmanship in a degree and manner not easily executed elsewhere. It is not enough that cannon locks be made with as much care as those for muskets:—they should be better constructed, and composed of better materials in proportion to the superior importance of their successful operation.

165. The certainty of being able to fire throughout an action, by means of a lock, instead of being obliged to resort to the match, is certainly a matter of great consequence. The difficulty and loss of time attending the fixing of a fresh flint in the heat of battle are such, that it is very rarely attempted; and, consequently, from the time a flint fails, the lint-stock is generally used. This is the great objection that was made to my Father's proposi-

tion; and the imperfection still exists. To remedy this, and secure throughout any action the advantages which the use of locks is calculated to produce, the lock, Fig. 2. Plate IV. is fitted with *two* flints, of which that in reserve may instantly be made to replace the other, by merely turning the nut, A, Fig. 4, and twisting round the double-jaws, B C, Fig. 3, which, turning freely upon the cock-pin, Fig. 5, are refixed in the notch, D, by screwing down the fly-nut, A. A washer of leather should be put on between the nut, A, and the double-jaws; but care should be taken that the washer fit not so tight to the cock-pin, as to act as a nut upon the thread of the screw; for if this should be the case, the motion of the jaws would be prevented, or retarded, when, having turned the nut, it is desired to shift round the reserve flint. The fly-nut should, perhaps, be slightly riveted on the cock-pin, by a few gentle blows upon its head. Should it thereafter be necessary to introduce a fresh washer, it must be made (by a punch issued for that purpose) with a cut through one side, P, Fig. 6, so that it may be slipped into its place by opening the cut sideways. Some spare nuts and washers should be issued with each provision of locks; and a pin turn-screw hung to each.

166. To show the utility of this invention, it should be remarked, that the urgent moment for resorting to a fresh flint is obviously when a flint fails. The gun being then loaded, and the line taken, the saving even of one second may be of the most critical importance. With men tolerably expert, the time required for bringing the reserve flint of the new lock into play, will never exceed five seconds; and its position cannot be otherwise than correct: but a flint fixed *by hand*, in the hurry of action, will not, in general, be well adjusted. If the edge be not placed parallel to the hammer, the flint is liable to be broken short off at the first blow; if the flint be so long, or placed so forward in the jaws, that the hammer touch it in shutting the pan, fire will be produced, and the gun most likely be discharged. It is not possible to guard against such accidents in shifting flints by hand in the heat of action, and, perhaps, under severe loss: but with the new locks, the spare flints must, of necessity, fall correctly into their places, from the construction of the cylindrical jaws. It is not, however, altogether on account of the saving of time in bringing a fresh flint into play, important as it is, that these locks have been devisèd and adopted. With common locks, the spare flints, turn-screws, &c. are *loose*

articles; and as such are liable to all the serious objections that attach in such cases. It matters not where they are kept; they may be mislaid or lost in the unavoidable confusion of severe action. The captain of the gun may fall: the gunner's mates, attending with the spare stores, may not be immediately at hand, or may also be carried off; and in every possible arrangement that can be made for the supply of these loose articles, the resource must be subject to some such contingency. With the new locks there is no such risk; the resource is certain. Every gun commences action with two good flints. If one fail, the other may be thrown into play in four or five seconds, and the back flint may be replaced at comparative leisure whilst the gun is reloading, without disarming the lock of its efficient flint.

167. The principle of the new lock having been approved, the Lords Commissioners of the Admiralty were pleased to direct that trials should be made of the practical efficacy of the instrument. This was accordingly done; when the new locks were found so efficient, and the reserve flint considered so great an improvement on the common lock,* that the Board of Ord-

* Letter A. Appendix.

nance, upon the recommendation of the Admiralty, directed* that the provision of ordinary locks for sea service should be discontinued, and those of my invention gradually introduced into the service.†

ON THE SERVICE-PRACTICE OF NAVAL ORDNANCE.

168. *Practice Tables.*—The tables that have been constructed for naval practice are very incomplete, when compared with the great variety of ordnance provided for sea service. There are no less than twenty-seven varieties of *guns,* (Table VII.) differing in line-of-metal ranges

* Letter B, Appendix.

† The example set so many years ago by the Navy, in applying locks to ordnance, has at length been followed in the land-service artillery. It is remarkable that so obvious an improvement should have been thus long delayed; for it may fairly be asserted that there is at least as much utility in such an application of fire-locks as in having substituted them for the match-locks formerly used with muskets. From suggestions originating in the invention already described, it has now been decided that locks should form, hereafter, part of the equipment of all natures of ordnance. The importance of this measure is so forcibly set forth in letter Appendix C. that I cannot withhold it whilst touching upon this subject.

from one to five degrees, stored in our arsenals for the use of the Naval Department. The most experienced artillerist would be unable to determine the particular elevation each of these pieces requires, to produce any given range; indeed there are no tables extant for the greater number of these guns; and of those that are in circulation in MS., some should be considered obsolete (Art. 162,) whilst others are, it may be suspected, not very correctly formed. I mention this to account for not having supplied a more extensive set of Tables in this work; but I have been careful to use the best, and Table VIII. is formed from media taken from them. Table XV. as has been shown, Art. 93, 94, may be received as the most correct register of the horizontal ranges of carronades.

169. *Distance.*—All vessels of war, from the sloop upwards, are armed with at least two natures and species of ordnance. The two-deck ship is armed with at least three, and so on. To combine the effect of a compound armament, or to regulate any simple practice properly, at any distance beyond point-blank range, it is first necessary to know pretty correctly the distance to the enemy's vessel. Good tables of practice must then be referred to, for the corresponding elevations; and instruments, or means of some

sort, must be used to point or lay the ordnance, according to the degrees of elevation noted in the Tables.

170. In all cases of gunnery, an accurate estimation of the distance is of the first importance. When considerable, it is usually taken very vaguely: but the necessity of knowing it accurately at long ranges, is greater, than when the projection is more direct, as in short ranges; for elevation is given to compensate for distance, and inaccuracy increases with length of range; but we cannot allow correctly for what is very vaguely estimated. At considerable distances also, there is more leisure and opportunity, as well as necessity, for determining them. In closer action all that is required is, to be certain that the enemy is within point-blank range: elevation is then useless. But when two vessels are opposed to each other at great distances, the effect will depend more upon skill, than upon rate of ship; and that vessel from which the distance has been most correctly estimated, will do most execution, supposing every thing else equal. Let those who may be inclined to disregard such niceties, refer to our actions with the Americans, (which will be more particularly noticed hereafter,) and they will perceive that in all our unsuccessful affairs

with them, our vessels were crippled in distant cannonade, before close battle commenced. This is fighting skill against skill, and shows the absolute necessity of attending, minutely, to every thing that can promote precision of fire at great distances. In such trials, the most devoted heroism will avail little, as we have seen, unless trained to precision. It is not recommended, or imagined, that trigonometrical nicety be used to determine the degree of *proximity* of an enemy who will fairly close for straight-forward battle; but should the opponent prefer to keep off for a time, to try the effect of his skill at long ranges, the importance of what has been recommended with respect to the training of gunners cannot be disputed, and an accurate knowledge of the distance at which the fire is to be returned, is the fundamental requisite for accuracy of practice. If this be only vaguely guessed within two or three hundred yards of the truth, the elevation cannot be right within two or three degrees. The consequent error may indeed be somewhat corrected, when committed, by observing the effect; but *trying the range*, as it is called, is, in such a case, extremely objectionable—discreditable to the system, and consequently injurious in reciprocal moral effects.

171. Numerous methods have been proposed for readily estimating distances, in acknowledgment of this fundamental term of accuracy. Of all the methods that have been proposed for this purpose, none appears so simple and obvious as making use of the different angles, subtended, at different distances, by the heights (when known) of the masts of the ship whose distance is desired, or using the ship's own mast as the given side of the triangle; and arranging the solutions in a table, to show the distances corresponding to numerous subtended angles; so that by simply measuring, with a sextant or quadrant, the angular height of a mast, (as is commonly done in line of sailing, or in chasing to ascertain whether the chace be gaining or losing distance,) and entering the column belonging to the case, the corresponding distance may be taken out. The French work, from which I have extracted their system of exercise as given in Part III. has furnished me with a Table (No. XX.) in which the heights of the masts to the head of the main-top-gallant rigging, and likewise to the main-top-mast cross-trees, above the surface of the water, at load water-mark, are given, for every rate and class of vessel. From these elements Table XXI. has been formed, in which the distances, expressed

in English yards and feet, corresponding to the angles subtended by the masts, are given in the first column. Thus suppose an enemy's ship is ascertained to be a first class, or 44-gun frigate, and that the measured angle, subtended by the main-mast to the top-mast cross-trees, is 3° 52′; the corresponding distance is 746 yards.

172. I have also ascertained, from authentic documents, that the lengths of the masts of American ships of war, are, in many cases, exactly the same as those of French ships of corresponding rates, as expressed in the tables; and, in general, so nearly alike, that this method may be used to estimate distances with tolerable certainty, in acting either against French or American vessels. It is not indeed likely that established dimensions, which are in general rigidly observed, will differ much from the quantities stated in a table which has been formed from official documents; if they should vary in some cases, the difference cannot be more than a few feet. Thus, in the case just given, where the height of the mast is 151 feet, and the distance 746 yards, if the actual height of the mast should be five feet less than expressed in the table, the distance would be 720 yards; if the height should be five more than assumed, the distance would be 769 yards:

either of these results is nearer the truth than the most practised judgment would usually guess; and at any rate sufficiently correct to produce good practice, if all the other essentials be well understood.

173. Table XXI. may also be applied to the important purpose of determining distances, making use of the ship's own mast as the given height, or side of the triangle, by marking upon it any of the heights expressed in the table; and placing an observer there, when required, to measure the angle ABC, Fig. 9, Plate IV. formed by the mast, when most perpendicular, and the line-of-sight BC. If, during the operation, the vessel should never be upright, the slant height AD, may easily be reduced to the perpendicular height DE, by observing the angle of heel, as shown by a pendulum hung from the centre of a graduated arc, and taking DE from a Table, constructed previously, to solve, by inspection, the right-angled case ADE, where AD is constant, the angle ADE (equal to the angle of heel) given, and the side DE required; but this will rarely be necessary in good fighting weather.

ON THE POINTING OF NAVAL ORDNANCE.

174. *Horizontal fire.*—When, without hesitation or manœuvring, ships come fairly to close action, all such niceties as the preceding may be disregarded. Superior precision, and rapidity of horizontal fire, will then determine the affair; it is important therefore to consider the best means of laying ordnance readily in horizontal or point-blank positions, in all cases. The usual mode of pointing guns horizontally, or point-blank, by a line of sight taken to the object, is by placing, upon the second re-inforce ring, the dispart taken at that part, and aiming direct at the object in the line AB, Fig. 7, Plate IV. This simple method has long been practised partially in the navy, the guns having been fitted accordingly, under the direction of the captain of the ship, in the manner pointed out in Captain Pechell's excellent little tract. But this was by no means generally adopted, and is besides an operation that cannot perhaps be very accurately or nicely executed on board a ship. If, therefore, no better means, or no instruments proper for pointing ordnance, be supplied hereafter, all sea-service guns should be fitted with the disparts, in the manner Captain Pechell recommends, in the ordnance arsenals.

175. *Expedients for regulating horizontal fire.* It very frequently happens that ordnance cannot be pointed accurately by sight, particularly in general actions, on account of the smoke in which the hulls of the contending vessels are usually enveloped. In such cases, therefore, it is necessary to resort to some expedient by which each piece of ordnance may be readily laid, and correctly fired in a horizontal direction, whatever be the position of the vessel. Various very ingenious contrivances have been devised to regulate generally the position of ordnance for horizontal fire. The most successful method of doing this was that practised by the gallant Sir Philip Broke in his Majesty's ship Shannon, in the following manner. The ordnance were first laid horizontally, by using a spirit level placed in their bores, when the ship was in harbour, without motion, and perfectly upright, as indicated by a pendulum suspended from the centre of a graduated arc, placed permanently in any convenient part of the ship. Tangent scales, or quadrants, were then fitted to each carriage, by which to correct the position of its gun for the angle of heel, so that the ordnance might very readily be reduced to horizontal positions, by observing the inclination of the vessel, as shown by the pendulum, and then

elevating or depressing the pieces with respect to their carriages, according as the vessel might heel-to, as in fighting to windward, or heel-off, as in engaging to leeward. Thus the inclination of the vessel being observed, orders were circulated, directing generally what degree or division on the gun scales should be used to compensate for the heel of the ship; so that the cylinders of her ordnance should be perfectly horizontal once in every roll, if not always nearly so, as in smooth water.

176. This ingenious expedient was also practised by other gallant officers, from the example of its distinguished author; and it is described in Captain Pechell's tract, already noticed. But although this contrivance approximates considerably towards accuracy, yet there is still the motion of the vessel to interfere with it; and, consequently, if no view of the enemy's hull can be had, and there be any motion, the precise moment is not indicated at which the ordnance come to horizontal directions. Now in close action, in moderate weather, or in engaging to leeward, the enemy's hull is commonly so effectually concealed in the smoke of both parties, as to be invisible, excepting perhaps by the flashes of his guns. Yet his position may frequently be ascertained by his masts being dis-

cernible above the rising smoke, when neither the hull—the horizon—nor the surface of the water can be seen; and, consequently, when there is no guide to point out the precious moment for firing with any certainty of effect. The direction of the discharge therefore, with respect to line, may frequently be well regulated by sight, when the elevation cannot; hence it is of vast importance to be able to ascertain the precise moment when the ordnance become horizontal, by attaching some simple expedient to each piece. In doing this, something must be intrusted to the individual intelligence of captains of guns. This might not be advisable under existing circumstances, but I proceed upon the hope and expectation, that future war will find our system of gunnery so improved, as to enable us to confide such duties to more cultivated functionaries.

177. The motion of a large ship, in good engaging-weather, is so easy and slow, that any thing of a pendulous nature, nicely fitted, will act with considerable accuracy;—witness the marine barometer. Thus the horizontal position of any piece of ordnance might easily be ascertained by means of a pendulum attached to each, as shown in Fig. 7 and 8, Plate IV. The pendulum should be fitted with a bar or index

H I, Fig. 8. (so balanced as to be perfectly horizontal when the pendulum is at rest) hung upon a pin C, inserted in the first reinforce-ring. A fine white line D E, perfectly parallel to the axis of the cylinder, (determined on shore by a spirit level placed first in the bore, and, when it is adjusted, removed to the ruler by which the quarter-line is to be drawn,) is painted on the side of the gun. Now whenever the upper part of the bar H I, coincides with the line D E, the cylinder of the piece must be horizontal. If the bar H I be made a foot long, the length of a degree to that radius (·22 of an inch) is such, that a deviation of the gun of even a quarter of a degree from the horizontal position will be very discernible. The shank of the pendulum should be bent so that it can neither touch the cheek of the carriage, nor the gun, excepting at the point of suspension. The bar and shank should be sufficiently strong to resist the shock of explosion and rough treatment, without bending; and the pendulum as long as the height of the carriage will admit of. After the gun is run-out and at rest, the pendulum should be touched once or twice whilst the gun is priming and pointing, if it continue to swing from the jerks of the preceding operation. This will demand time and coolness!—true; but it will

very much increase the effect, which, in the case now under consideration, cannot otherwise be depended upon. When not in use, the pendulum should be secured properly in a case, or groove, provided for it upon the inside of the carriage, as shown by the dotted lines, 1, 2, 3.

The man who fires, having the trigger-line in his hand, will observe the pendulous-bar, if he cannot get a sight of the enemy's hull; and pull the line when he finds the index H I approach to coincidence with the quarter-line D E.

Those who may be disposed to object to such applications of the pendulum, on account of the disturbing effects of the vessel's motion, are requested to observe, that in the expedient already noticed, Art. 175, a pendulum was used, indirectly, to regulate the positions in which the ordnance should be laid, with respect to their carriages, in reference to the observed angle of heel, so as to produce horizontal fire nearly. Now there can be no doubt, that the more direct application of any mode of correction is always the most advantageous. Those again who object to the principle of intrusting so much to captains of guns, show, in fact, the necessity of instructing them; and the observations, by whomsoever made, must be considered

favourable to the measure which has been proposed in Part I. to obviate all such objections.

178. *Sights.*—The only scales hitherto provided in the ordnance arsenals, for pointing naval guns, are the quarter-sights engraved on the sides of the base-rings, in quarter degrees from point-blank to two or three degrees. For close, horizontal fire, guns may be laid by the point-blank quarter-sight, with sufficient accuracy, by simply bringing the notches upon the base-ring and muzzle to bear upon the object aimed at; the elevation will then be correct, and, in close action, the line will be sufficiently true. But when the distance is such as to require any elevation, this method of pointing guns becomes totally inapplicable to naval service; because, unless the line be correctly taken, over the top of the gun, at the same time, great errors in horizontal divergence would be produced. In land service the line may be taken over the top of the piece, and the elevation afterwards regulated by the quarter-sight; but in naval practice it would be necessary to execute these two operations simultaneously, and this cannot be done with any accuracy. It is, therefore, a matter of great importance in all naval artillery-practice, to reduce these two operations to one aim. For this purpose, sights, or scales, of

various natures have been devised, to correct for elevation, and take the line by the same sight. The means of effecting this are usually by sights placed on the top of the gun, and this method of *top-sights* appears to have been generally practised in the naval service. In the Shannon, San Domingo, &c. moveable sights of different heights were fixed upon the second reinforce-ring; one adjusted for point-blank direction, the others for different elevations as far as line-of-metal. The only fixture upon the breech was a confining sight to warn the captain of the gun to keep his eye down to the level of the notch in the base-ring, in line with the other sight. The ranges corresponding to low angles are unquestionably the most important and decisive, for beyond line-of-metal range, the effect becomes very uncertain in naval gunnery; now the means, as well as method, just described for pointing ordnance, is so simple, so snug, so little likely to be deranged, and so generally understood, that all guns should be thus fitted, in addition to any more delicate or correct apparatus that may be hereafter supplied for this purpose. Instruments of delicate construction, standing high upon the top of the breech, as sights must do to be capable of giving considerable elevations, will be exposed

to damage at every instant, upon the quarter-deck, fore-castle, and gang-way, from the fall of rigging; and in the upper or main deck of line-of-battle ships, or frigates, from working the tacks and sheets, in manœuvring. Another serious objection to top-sights standing considerably above the breech is, that the lowness of the upper sills of the ports very often prevents the use of *any* tangent-scale, when a ship fights her lee-side under pressure of a smart breeze, particularly if much actual elevation be required.

It appears to me also, that whenever there is so heavy a sea as to occasion much and rapid motion, any sort of close-sight, having a small aperture to peep through, (however just the principle and beneficial the use in smooth water,) will not be found so applicable, as the simple method already described; because the quick motion of a ship affords but a mere glimpse of the object, without distinct warning of the approach to coincidence, when viewed through a small opening. Without disparagement therefore to more refined means of pointing ordnance, it may be permitted us to recommend, that in every case the more simple method already noticed be also provided. This is necessary, not only from the considerations already advanced, but also from those which relate to the fitness

of the crew to appreciate properly, and use fairly, any delicate methods and instruments. The utility of top-sights, fitted with mathematical precision, is sufficiently obvious; but this will not ensure the benefits they are calculated to produce under the management of a well-trained crew, should they ever be issued to ships manned, for immediate service, by persons who may never, till then, have seen them. Such methods demand, absolutely, a great deal of previous training; and I am persuaded that instrumental sights which admit of nice adjustments corresponding to different elevations, intrusted to the handling of untrained men, would very frequently occasion the most serious consequences. Action may commence at considerable distances, which may rapidly lead to close battle; and should corresponding alterations not be made in the original adjustment of the sights for long ranges, what may not be the consequence? I am confident, therefore, that I shall have the support of all those who are favourable to the introduction of instrumental sights, when I submit, in this respect also, the necessity of having depots for training naval gunners, and for circulating and establishing all improvements, in such numbers and in such a system, that no vessel shall ever be fitted for

service without having on board some hands well trained to the exercise and practice, and fully instructed in the use, of every established instrument and method for ensuring accuracy.

179. *Tangent Practice-tables.*—The naval profession should be well skilled, in all its branches, in every possible expedient for immediate substitution in its uncertain and contingent operations; it may, therefore, be useful to provide for, and explain, a method of regulating elevation which may be easily practised, should other means fail, or be found inapplicable to the immediate case, or to the quality of the crew.

In suggesting this expedient, it is not intended to interfere with, or attempt to supersede any approved usage that can be properly applied. The substitute method is only proposed for use when other means fail; it can, therefore, do no harm, and, consequently, can only be beneficial in its operation.

The method of pointing ordnance by tangent-practice, in the manner to be explained, was suggested to me by Sir Philip Broke; and it forms the basis of the French principle for regulating elevation (148, note 4.), which however, by a complicated use of the line-of-metal sight, is, in itself, extremely objectionable.

180. The elevation given to a piece of ord-

nance, at any range beyond point-blank, is to allow for the space through which the projectile falls by the action of gravity, in the time of flight. This allowance is rated in degrees and minutes, in all tables of practice; but the space through which the projected body descends, is equal to the tangent of the angle of elevation, the range being radius: that is (Art. 6, Fig. 1 and 2.) when the ball falls at I, it will have descended through a space equal to HI, in the time AH. Now suppose a gun A, Fig. 10. Plate IV. were placed at a known horizontal distance AB, from a vertical object B C, upon which is fixed a distinct mark D, whose height, D B, is known to be equal to the tangent of the elevation given in the tables, for the range A B as radius. The best aim that could be used to hit the body B, would be to point the gun at D, using, of course, the dispart sight, parallel to the bore. Now if, besides D, there were on B C several other marks, E, F, G, H, I, K, whose heights above the horizontal line B C, being known, were found to correspond with the natural tangents of the angles of elevation expressed in the tables for certain ranges as radii; those marks might be aimed at with tolerable certainty of practice, at those ranges or distances. Upon this principle I have formed the

tangent practice-table No. XXII. constructed from our best tables of the ordinary form, and from the table No. XX. which shows the height above the level of the water, of the different parts of all rates and classes of French ships; and it will answer also for practice with others (172.)

Meeting here the objections that may occur to this method of pointing ordnance, it must be observed, that a knowledge of the distance is not more material to this, than to the ordinary practice; and that as the heights to be aimed at are actually calculated from the degrees of elevation given in the tables, this method only differs from the other, by the substitution of a denomination which refers the direction, or pointing, to known heights in the body aimed at, instead of regulating the practice by minute divisions on the gun-scales or sights. It appears to me, and I am confirmed in the idea by the opinions of many professional persons, (and chiefly by that of the distinguished officer already named,) that, with people not highly trained to the intricacies of elevation, the practice of naval ordnance might thus be simply and uniformly conducted, by a general order indicating the aims that should be taken; and this in a

manner that cannot be wrong, if our ordinary tables be right, (and if not, this will affect any practice,) and so simply, that the most unpractised seaman, without knowing why, might, by merely aiming his gun at a prescribed object by the point-blank sight, be enabled to do as much service as an old gunner who does the same thing with an instrument, adjusted to degrees and minutes, in a much more complicated way: and, as has been shown (178), there are cases in which this mode of pointing may be particularly valuable.

181. The use of the table is obvious.—When the distance is known (171, p. 214,) enter, with it, the table belonging to the corresponding nature of gun; and opposite to that distance, found in the first column, is given the part that should be aimed at. The dispárt-sight is used till the actual elevation becomes equal to the line-of-metal elevation, after which the latter is used; otherwise the line-of-sight would pass over the opponent's mast-head, at any distance beyond that due to the angle it subtends. The elevation being thus guided principally by pointing at various parts of the masts, the shot will be particularly aimed to take effect low, in these vertical lines; and consequently this mode of

regulating the practice, whilst it is calculated to hit the hull, is aimed to strike the masts, in parts most likely to fell them.

No. XXII. is a table of this nature for long 24-pounder guns, on the main-deck of a frigate. The long 18-pounder practice has been much over-rated in some of our tables.—The practice in Table XXII. may serve for both. (See *Note*, Table VIII.) Table XXIII. is a tangent practice-table for short 24 and 18-pounders, from the main-deck of a second-class frigate. I have not arranged tangent-tables specially for the service of two-deck ships, because, in firing at such large bodies, the same degree of precision is not so indispensable, as in firing at single-deck ships; and the tables arranged for the one, may therefore be used for the other, with a little correction for difference of height, which may soon be made from Table XX.

It is for the purpose of teaching, practising, and improving the accuracy of this method of pointing naval ordnance, that it has been proposed (p. 22.) to fit the practice-screens or targets with poles to represent the masts of an enemy's vessel; and independent of the principle of regulating the elevation by tangent-practice, it may be relied upon, that fitting the targets with vertical marks, similar to those which in action

are usually the chief foci of the aim, cannot fail to promote considerable expertness in dismantling practice.

182. *Tubes and Priming.*—In the practice of naval gunnery, it is most particularly important that the actual delivery of the charge from the cylinder of the piece should follow, as instantaneously as possible, the action of the lock; for whilst the object aimed at is continually changing its relative position, the direction of the gun is varying so rapidly, that if the medium which is to convey ignition to the charge, act not very smartly, the elevation of the shot's departure may be two or three degrees above or below that in which the gun was pointed, when the trigger was pulled. The nature, quality, and care of tubes and priming, therefore, are considerations which may justly be reckoned as most particularly affecting the efficiency of practice; and the most minute differences that can be detected, by the nicest means, in the progress of explosion, should be allowed decisive weight in judging and selecting the medium to be used. For suppose a vessel, in action, be rolling eight degrees, performing each roll in about four seconds of time. When the nature or condition of the tube and priming is defective, or bad, it will very frequently happen that an interval of one second of time, and sometimes considerably more, will take

place between the pulling of the trigger-line, and the discharge of the piece; and in that time the elevation of the gun would alter two degrees! With any uncertain or sluggish action of this nature, therefore, it is useless to expect much accuracy of effect, even with the best trained men, and with all other means perfect. The greatest expertness in catching the precious moment for firing—the nicest pointing—the finest instruments, all avail nothing, if this simple, and too often disregarded little agent, prove defective in the least degree. Much has been attempted on this subject; but after as many trials as ever have been made upon this important matter, I am convinced, that a priming of pure powder is infinitely preferable to any mode of conveying ignition to the tube by quick match, or by a double tube, or by any other squib-like medium. This may be easily tried; and I earnestly recommend all naval officers to make such trials of their tubes very frequently. The test may be very accurately made in the following manner. Prime two unloaded adjoining guns, in the two different manners it is desired to prove. Tie the trigger-lines together at a point equi-distant, and retired from each gun: strike both locks at the same instant, by the same pull; and that

medium which soonest causes sound in the hollow gun, is unquestionably the best.

183. But although powder is the best priming that can be applied, yet the use of a priming-horn is so objectionable, from its liability to spill the powder about the decks, that various methods are practised, to prevent the necessity of using loose powder, and at the same time to preserve the priming from being blown away by draughts of wind through the ports, or damped by the wet fingers of seamen, who, the instant before, may have been handling tackles or breechings wet with the spray of sea, rain, or deck water. A common method is to attach a priming cartridge to each tube. This, though a great improvement, is liable to some objection—the paper frequently breaks, and spills the powder; and at all events does not preserve it from becoming damp. In the Shannon, the priming powder was kept in small tin tubes, each containing an ample priming. This is a better plan; but in both cases neither the head of the tube nor the train of powder between it and the lock, are protected from sea-spray, rain or wind; and these considerations induce me forcibly to recommend the French expedient, already explained in the note to Art. 122, (Fig. 4, 5, Plate III.) with this addition—

that the lower part of the edge of the conical cap, be hollowed out to embrace the projecting end of the pan, to prevent the tube from being pushed or blown aside.

ON THE DISTURBING EFFECTS OF THE ROLLING MOTIONS.

184. In every case, when there is much motion, the shot will not be delivered from the cylinder, till its direction is altered, more or less, from that in which the piece was pointed when the trigger was pulled. It is therefore not only vastly important to use those means (182, 183) that are best calculated to produce the most instantaneous discharge possible, but also to consider which direction, and what particular part of a vessel's motions, are most favourable for firing the ordnance with the greatest prospect of effect—whether to fire on the weather, or lee-roll, and at what particular stage or crisis of the motion. These are very important, but very difficult questions, on which I rather wish to invite discussion, than to presume to pronounce any terminal doctrine. I shall however state my opinion, noticing at the same time what may be advanced against it.

185. In close action, in smooth water, it is not perhaps material whether the ordnance be fired with, or against the roll, provided the captains of guns judge, correctly, how much their pieces should be pointed above or below the part intended to be hit; but when there is much swell, it is by no means indifferent which of these motions should be preferred, nor what modifications should be admitted for particular cases, in any general maxim that may be established on this subject; and this we shall now endeavour to show.

186. The rule generally laid down for observance in action, is, to fire when the vessel is nearest on an even keel, that is, upright.

To deal, simply, with considerations respecting the rolling motions only, we shall suppose the vessel to have the wind on the beam; for if hauled upon a wind, the motion would be compounded of rolling and pitching, by the vessel laying across the swell. Now a vessel under sail, with the wind as described, is nearest upright at, or near, the end of the roll to windward. Were it not for the action of the wind on the sails, she would be upright when she comes to the top of a wave; but this is not the case in a smart breeze, because it requires some degree of counteracting power from the

swell, as the vessel sinks upon a wave, to compensate for the heel occasioned by the wind. In a heavy swell, however, a vessel will roll to windward, considerably beyond the upright position; but in stating a case proper for action, we should not suppose the sea to be so rough, as to make the vessel incline much to windward. Now a vessel brought to that momentary pause which takes place on the termination of the weather-roll, just before she begins to feel the rising influence of the next coming wave, must be in the hollow, or trough of a sea; and in such a position will have a less commanding view, and *prise* of her enemy, than if he were seen from the top of a wave. This preliminary observation may perhaps be considered sufficient to show, that the maxim of firing when the vessel is on an even keel, should not be too generally, or absolutely, enforced; and having submitted this, we may proceed to consider the important question that results naturally from it,—whether it is most advantageous to fire with a rising, or with a falling side.

187. A vessel engaging to leeward, that is, fighting her weather-side, must be in the trough of a sea when the side engaged begins to rise; and whilst it is rising, she must be performing a lee-roll. The disadvantage of firing from the

hollow between two waves having already been shown (186), the inexpediency of firing at the *beginning* of the rising motion, is also proved, for the one ensues immediately from the other: and a very material objection to the practice of firing *during* any part of the rising motion. comes from this—that the lee-slope of a wave being always more abrupt or steep than the weather-side, the change which takes place in a vessel's position in making a lee-roll, accelerated and increased by the action of the wind, is much more rapid than in rolling to windward; and consequently the direction, or elevation of the ordnance, will be much more quickly and considerably disturbed, in firing with the rising, than the falling motion, in this case. It appears to me, therefore, that in fighting the weather-side, we should prefer to fire at the pause immediately before the commencement of the declining motion, (unless the vessel heel so considerably as to incur danger from the increased action of the recoil,) because the ship being then on the top of a wave, will command a better view of the enemy, and the declining motion will be operating to lessen the slope in the direction of recoil.

188. In fighting to windward, some of these arguments are reversed.—The declining motion

of the side engaged is then a lee-lurch; and at the commencement of that motion, the vessel must be in the trough of the sea. We should therefore so far modify the maxim already suggested, as to fire at the end of the falling motion of the fighting, or lee-side, when the vessel comes to the top of a wave, so that the actual discharge may not take place after the pause which attends the change of motion.

189. But modifications, governed by various considerations, should be made in all such maxims.—If, in the first case, (fighting the weather-side,) a ship be heeling under the influence of a strong breeze, her guns, fired at the commencement of the declining motion, or at the pause which precedes it, will rush in with such violence, from the inclination of the deck being in the direction of the recoil, that the breechings and ring-bolts will frequently be incapable of resisting so severe a shock, particularly when the guns are loaded with two shot: and in such cases, consequently, the ordnance should not be fired till the declining motion be partly performed.

It may not be improper here to remark, that the breechings of naval ordnance, in frigates particularly, are in general considered too weak; and as those on the gun-deck are soon damaged by being continually wet, it is very

essential always to have spare breechings ready fitted, and to exercise the people frequently to rig them quickly. Carronades should always be fitted for action with second breechings. In the Shannon the preventer-breechings were reaved through holes in the timbers, and toggled on the outside; and to relieve the ring-bolts and breechings, chocks of timber were placed underneath the hinder part of the slides, when fighting the weather side, so as to lift them nearly to a horizontal plane when the vessel was heeling seven or eight degrees. Carronades thus fitted, run in with less violence, and are more easily run out; and with this species of ordnance, such precautions should invariably be adopted. If a *gun* break loose, it may be rendered serviceable again in a few minutes; but should a carronade break its breeching, or draw a ring-bolt, she is very apt to turn over, or split her slide to pieces. In firing carronades with two shot, these precautions are absolutely indispensable; for although this species of ordnance is not calculated to discharge two projectiles, in common, yet when within a few yards of an enemy, double charges may be used with great effect, either composed of round and grape or case, or of two round shot, according to the circumstances of the action. Thus, in fighting to leeward, the inclination of

the enemy will expose his deck so much to severe effect from grape or case shot, that the double charge should be formed by such an addition accordingly. In fighting to windward, on the contrary, the weather side of an enemy heeling off, will be so much exposed as to be favourable to the use of two round-shot, whilst the inclination of her deck protects her people from grape or case. Thus modifications in any maxims, as to the most favourable moment for firing, should also be governed by the motion of the enemy's vessel.

190. It appears to follow, from what has been advanced, that balls intended to take effect upon the hull of an enemy, should rather be discharged with a falling, than with a rising side; but that such pieces as may be appointed specially to act against the masts and rigging, should, on the contrary, be fired with the rising motion, the aim being taken low.

In all close actions, the great object should be to inflict as many wounds as possible in the enemy's hull. This is particularly desirable in actions between carronade-armed vessels, because the magnitudes of their shot are so great, in proportion to their scantling, that it requires much fewer body blows, in proportion, to drive small vessels to their pumps, than thus to affect

large ships. One or two 24lb-shot taking effect below the water-line, and perhaps perforating both sides of a small vessel, will, in general, either force her to surrender, or send her to the bottom, though she may not have sustained any other material damage, and no loss of crew; and such an injury is much more likely to be occasioned by firing with a falling, than with a rising side.

Some of the actions between British and American sloops afford some very instructive illustrations on this important question. In the action between the Hornet and the Peacock, the decisive importance of a few body wounds, was unhappily too strongly displayed. The American ship was a good deal injured in her rigging, though comparatively little damaged in the hull; but the British sloop was forced to surrender entirely in consequence of having been hulled so low, that the shot holes could not be got at; and she sank a few minutes after, having been obliged to yield to this fatal circumstance only!

The Avon was brought to the painful necessity of striking to the Wasp, from being reduced to a sinking state by body wounds; and went down immediately after the last of her brave crew were removed. In this affair the Ame-

rican first crippled the Avon's rigging, with dismantling-shot from long guns, and then aimed at her hull with fatal success. The Wasp does not appear to have been materially injured; for she escaped from a vessel (the Castilian), in a short chase that took place, before she was recalled by the Avon's signal of distress.

In these two actions, it is clear that the fire of the British vessels was thrown too high, and that the ordnance of their opponents were expressly and carefully aimed at, and took effect chiefly in, the hull. The inferior effect of our fire may partly have arisen from such errors in carronade practice as have already been noticed; but it may be suspected to have arisen, chiefly, from not having chosen the most advantageous moment for firing; and this we shall be better able to show, by reviewing the action between the Frolic and the Wasp.

This affair will be found to support, very strongly, what has been said against the measure of firing with the rising motion. The contending vessels were pretty nearly matched in armament; but the Frolic went into action under the serious disadvantage of having her main-yard sprung, and useless. The Wasp, having the wind, came down and engaged the Frolic to windward, on the larboard side, and conse-

quently fought her lee side, against the weather side of the British sloop. The American was considerably injured in her rigging early in the action, and also received a few shot in the hull; but much more serious damage and severe loss were sustained by the Frolic. This difference of effect may fairly be ascribed, in a great degree, to the crippled state in which our sloop commenced the action; but we cannot hesitate to allow, that it may also have arisen from the circumstance of "her motion being much more rapid and violent than that of the Wasp," as has been remarked by a very intelligent writer.* But the "rapid motion" which so much disturbed the direction of her fire, appears to have been occasioned by the quick dips of lee-lurches; for she fired with a rising side, and, as there was a heavy swell, this motion must have very rapidly disturbed the pointing of her ordnance, whatever was her trim. That the Americans did not fire with the rising motion, we know from the parties themselves;—that they could not fire in the hollow of the sea, in such a swell, is evident;—and that they did not fire in the lee-lurch is clear from the admitted fact, that the ship rolled her carronade muzzles to the water's

* James's Naval Occurrences, p. 146.

edge; and from this we may infer, with certainty, that she fired, in general, from the top of the sea, towards the termination of the falling motion. That the British sloop fired with the rising motion, is no less certain—it is so stated in accounts which, however exaggerated in regard to strength and comparative loss, are unhappily true in the main feature; and the explanation of this affair, from authority, so far as it relates to rapidity of motion, states a cause of error which every seaman knows must be greater in a lee-lurch, than in a weather roll.

If there be any truth or accuracy in these remarks, this case illustrates, very forcibly, what has been offered upon the important question—whether it is most advantageous to fire with a rising, or with a falling side; and, together with the losses of the Avon and Peacock, show, that this reasoning applies particularly to cases of fight between small vessels.

A close review of these operations shows clearly, that the Americans prefer to fire with the falling motion; and knowing what the character of their practice is, as well as its principle, we may very fairly admit this fact to have considerable influence in determining the preceding question.

It has always been remarked that, in action

with French vessels, our ships have invariably suffered more in the rigging, than in the hull; and this appears to have been the case, not only in later times, when it may have arisen from deficiencies of instruction and practice in their service, but also in former times, when they possessed both in very considerable degrees. The general use they make of the line-of-metal sight may partly account for this, in some cases; but to ascribe it altogether to such gross and obvious errors in the pointing of guns, at periods when gunnery was well taught, would be an erroneous supposition, and we must therefore seek for some other cause. It appears to be an old established maxim in the French Naval Practice (pages 173, 174,) "always to fire when the side in action rises, because, in the rising motion, the shot which miss the hull may take effect in the rigging." This appears, at first sight, a very plausible reason for adopting such a principle of action; but when it comes to be closely analyzed, it will be found to be liable to the objections I have endeavoured to point out in Art. 186, 187; and also sufficient to account for the inferior degree of damage which our vessels have usually sustained in their hulls, in actions with French ships.

191. Great effect will always be produced by

using grape-shot from heavy guns, in close action; and it appears to me that this very destructive nature of projectile is not so generally used as it ought to be. A charge of grape-shot for a 24-pounder gun, is composed of twelve two-pound balls (Table XVIII.) So great a proportion of an enemy's side is opened by the large ports of a carronade battery (four feet in width and more in height), that grape, or case shot, seldom fail to commit great execution, not only from entering these large ports, but also from cutting the rigging, and entering the lower ports. Case shot for 24-pounders, being composed only of 8 *oz.* balls, have not power to do much mischief against the material of an enemy, and should therefore only be used, in good opportunities, specially against the *personnel;* but grape shot may be used in certain proportions from heavy guns, in any close action, because they are capable of committing infinite ravages against both men and material. Two-pound iron balls will penetrate the enemy's barricade defences on the upper deck, and though they cannot penetrate a mast, or by any direct wound bring it down, yet they can break chain plates, cut shrouds or stays, however thick, and from the number of such chances, will be very likely to dismast the enemy in a strong

breeze. In close action, therefore, the alternate main-deck guns may be loaded with round shot and grape; the others with two round shot.

192. *Rapidity of Fire.*—In close action, rapidity of fire is of the most decisive importance, provided accuracy be not sacrificed to it; for in proportion as we increase rapidity of fire, with equal precision we, in fact, increase our force. In close battle, when it is not well possible to miss, the vessel that can soonest reload her ordnance, and give her second broadside, supposing both ships to have opened their fire nearly at the same time, must have a prodigious advantage. The power of doing this with efficacy, as well as rapidity, can only be acquired from the constant practice of every minute detail and motion relating to the manual exercise, and to the pointing of the ordnance. For the first round or two, I am inclined to think, that in close position, the cartridge, shot and wad, might be set home at one operation, after the piece has been carefully spunged; having previously prepared wads not too tight (106). This method of loading is frequently practised with heavy ordnance on shore; and I am not aware of any other objection to it in naval service, than that which is founded upon the cir-

cumstance of the ball being apt to roll upon the tie of the cartridge, and thus jam in the gun;* but this may easily be prevented, by cutting it short off, or by fastening it round the body of the cartridge. This method of diminishing the time of reloading may perhaps be considered rather deep play; but in close action, so much of a battle is decided by the first few rounds, that we may certainly be permitted to adopt any expedient whose partial failure cannot occasion defeat, but from the success of which, speedy triumph may ensue; and this expedient to gain rapidity of fire is precisely of this character.

193. In close, critical action, the great object should undoubtedly be the enemy's hull. For this great purpose, it is better that the pointing of the guns should rather be calculated to let inconsiderable errors take effect low, on the body, than to aim high, and missing it, to hit the rigging. A shot striking the hull, may carry away a mast, and do execution to the armament and crew besides; but a ball taking effect high, in nearly the same vertical line, can injure the rigging only, and that not with so much effect; for a lower-mast, wounded aloft,

* In this manner a gun was burst in the Princess Royal at Toulon, by which accident forty-five men were killed and wounded.

will be more likely to stand, than if the same wound were inflicted by a shot which had previously perforated the ship's side at the upper deck. It is a great waste of means therefore to apply round-shot of large calibre, to the remote chances of destroying rigging, which, branching out from one trunk or stem, may be more effectually felled by a blow otherwise destructive at the same time. The important, decisive effect of horizontal fire should therefore never be lost sight of, or diverted from its main object. I do not say that it is not extremely important to effect destruction of rigging; but this should not be attempted by a supplementary speculation that must interfere with the far more important and decisive use the ordnance should be put to. When vessels are once fairly engaged in close, critical action, which can only terminate in defeat or victory, the main object should be to kill and wound as many men as possible. *Before* the contending ships approach to this critical proximity, is the proper time to try what skill and precision can effect upon the enemy's masts and rigging; and vessels fitted with long guns, and manned with expert gunners, will always do well to make such previous trials of their arms and qualities; and with good, circumspect management, close action will not fail to begin with commensurate

advantage; but once committed in close battle, rapidity of horizontal fire is the main object; and well acquainted, I hope, with the effect of cannon shot, I have no conception that a vessel, equipped in a proper manner, and possessing gunners trained in the way I propose, could, by any possibility, fail in tearing to pieces, in ten minutes, any opponent who did not prevent it, by committing still greater ravages on his antagonist.

Thus, by precision of fire, great advantages may be reaped before close action commence; and in this cool, slow, collected trial of skill, we should observe every possible refinement to gain, or even to approximate, in any degree, towards accuracy. I must, however, beg to be understood as recommending much of what I have said on those refinements that are conducive to accuracy, only for use in distant cannonade; relaxing, naturally, in favour of rapidity, in proportion as proximity demands rather the latter, than the former observance.—Scientific gunners may, when it becomes necessary, apply their skill to very efficient rapidity of fire; but inferior training cannot improve coarse, random rapidity, into scientific precision.

194. *Destruction of Masts and Rigging.*—When it is expedient to aim partially at the rigging, one or more guns, conveniently placed, and fitted expressly for such purposes, should be named for this service specially, and loaded accordingly. The main-deck guns cannot be elevated sufficiently to effect this, when the enemy's ship is close; and as case or grape-shot from carronades scatter so much as to be very inefficient, ships should always be provided with at least one long gun on each side of the quarter-deck and forecastle, for this important purpose. These dismantling guns should be capable of being elevated to 30° at least; so that the enemy's main-top might be under the command of a powerful fire of case, at pretty close quarters. Guns thus mounted might be fired, en barbette, over the barricades or gangways, and easily brought to bear upon an enemy along side, or laying across either stern or bow. In the position in which the Cleopatra suffered so much from the Milan, and in which the Phœbe was so annoyed by the Didon, when Captain Baker so gallantly captured her, the quarter-deck 9-pounders might both have borne with ease upon the enemy's tops, when no other guns but the stern chasers could be used.

195. As in such positions as these, all broad-

side guns become useless, ships' crews should be exercised to form themselves, rapidly, upon the deck, boats, and booms, when called for small-arm duties. If, quickly ranging themselves thus, they be instantly supplied with arms, the enemy may soon be driven from their tops; and subduing the fire from thence, is a favourable preliminary to the assault by boarding.

The best method of opposing the enemy's top-men is to have a few expert marksmen similarly posted; but at close quarters, ordinary case shot, or large charges of musket balls, may be used with great effect from the elevating guns; and for this purpose some rounds of this nature of charge should always be kept ready for any piece that may have the best opportunity of using them with effect.

196. Dismantling rigging, and carrying away spars, are more likely to be effected when it blows fresh, than in light airs. Carrying away a stay, or a few shrouds, or wounding a mast or spar, in a strong breeze, may occasion a serious crash, which in a light wind would not ensue. This is particularly the case in tearing sails. In moderate breezes, the perforations of shot leave only small holes; but in strong winds, a sail frequently splits upwards, as far as the

reef-bands at least, as soon as it is perforated. As therefore a ship is more easily crippled, in strong winds, by endeavouring to tear her sails, than in any other manner, dismantling-shot should in such cases be freely used against her canvass; but in light winds, masts and spars should be chiefly aimed at.

197. *Dismantling-shot, in Chase.*—Whether pursuing or pursued, the only chance of stopping an enemy is by bringing down some of his rigging; it is therefore most important to consider the best mode of effecting this. The random aim of a whole broadside battery will be much less likely to accomplish this, than the cool and careful use of one well-served gun. Hauling-up, or bearing-away, to rake a flying or a pursuing enemy, always produces a very random volley; for as the change of course, must occasion much loss of distance, it is necessary to perform it so quickly, that the effect is seldom good, because the distance, or range, alters very much before the vessel comes to a position proper for opening her broadside fire; and this alteration of position, brings with it a great and unknown alteration in her inclination, and, consequently, a considerable change in the elevation at which the ordnance may have been laid, and which there is not time to correct. It is almost incredible, indeed, how

little effect is produced by this sort of raking fire; and the observation requires therefore to be supported by facts. In a certain action, a 74-gun ship bore up across the stern of an 84, to rake her, at a cable's length distance, in moderate weather and smooth water. The 74 had been upon a wind, and not having, perhaps, allowed for the alteration of elevation that would take place after bearing up, not one shot took effect! A proof of what may be effected against the *personnel*, by yawing, and giving a *close* raking fire of well-directed *grape*, was gallantly shown by the Inconstant, commanded by the late Admiral (then Captain) Freemantle, who, keeping in the wake of a line-of-battle ship, gave a raking fire of grape with tremenduous effect upon her people, who were very much exposed in striving to clear the wreck of her top-masts, which had been carried away by an overpress of sail.

198. The attack of the American squadron under Commodore Rogers, on the Belvidera, Captain Byron, furnishes a strong proof of the inefficacy of vollies of raking fire, with round shot. Captain Byron seeing the squadron bearing down upon him in a suspicious manner, and having reason to expect that war had been declared, very prudently kept away also; and

gradually making sail, a chase ensued, during which the President, outsailing her consorts, came up with the British frigate.

The President first attacked with a heavy bow-gun, with which she killed and wounded nine men in the Belvidera; and by continuing to fire from single guns, deliberately aimed, without altering the ship's course, did much further damage to the chase. But when, gaining further on the British frigate, the President yawed and gave her broadside volley, (which was several times repeated,) she never did the Belvidera any further material damage, beyond cutting a brace or two, and wounding a few spars! Our frigate answered these attacks, deliberately, with her stern and quarter guns, with such effect, that the President (having had a gun burst) suffered more than her expected victim; and the steady and determined manner in which Captain Byron conducted both his defence and his retreat, reflects on him immortal honour, and on his crew a full share of credit. May these facts support my endeavours to show how much more may be executed by cool, deliberate aim with single guns, in the hands of well-trained gunners, than by repeated random vollies of whole broadside batteries!

199. In the chase of the President, and the

action which ensued between her and the Endymion, some of the best gun practice ever effected by British seamen was displayed. This operation also affords matter for remark, as to the effect of dismantling fire in chasing.—The Endymion's sails were completely torn to pieces, and her spars and rigging much cut, by the American dismantling-shot. One of these shot cut away twelve or fourteen cloths of the Endymion's fore-sail, stripping it almost entirely from the yard.*

* The American dismantling-shot, which tore the Endymion's sails, was composed of four or five iron bars, each about two feet long, fastened by ring-heads to a strong ring. Shot of this nature, and also bar-shot, were very abundantly and successfully used in many of their dismantling attempts.

PART V.

OBSERVATIONS ON SOME RECENT NAVAL OPERATIONS, AND ON THE TACTICS OF SINGLE ACTIONS.

200. A REVIEW of the tactics of some of our naval actions with the Americans, will be found to yield many useful deductions in support of much that has been advanced in the course of this work.

The reasons which have induced me to attempt a review of these important occurrences, are to show that the American tactics were so circumspectly and cautiously adapted to the superior powers of their armament, that even when opposed to very inferior numbers and quality of ordnance, they would neither approach, nor permit us to join in close battle, until they had gained some decisive advantage from the superior faculties of their long guns in distant cannonade, and from the intrepid, uncircumspect, and often very exposed approach of assailants who had long been accustomed to contemn all manœuvring, and who only considered

how to rush soonest into yard-arm action. Such, unquestionably, was the character of these proceedings. The uncircumspect gallantry of our commanders led our ships, unguardedly, into snares which wary caution had spread; and, in point of fact, our vessels were, in almost every instance, so crippled in distant cannonade, from encountering rashly the serious disadvantage of making direct attacks under the powerful fire of whole broadside batteries, that all those close actions which terminated unfavourably to us, may fairly be considered to have been fought under very disadvantageous tactical circumstances, even had the force of the contending ships been equally matched.

201. In the action between the Macedonian and the United States, the American frigate avoided close action for a full hour after fire commenced. Captain Carden states, "that from the enemy keeping two points off the wind, the British frigate was not enabled to get so close to her as was desired; and that it was not till after an hour's cannonade, when the enemy backed and came to the wind, that close battle commenced." This shows that Commodore Decauter's plan of operation was to keep at long-shot distance for some time, to try the effect of relative precision of fire,—to avail himself of the superiority of

his long 24-pounders over the 18-pounders of the Macedonian—and, by edging away from the British frigate, (gallantly attempting to close, directly, from the windward,) to prolong a preliminary operation so much in his own favour. How far he succeeded, is shown by the opinion of the Court Martial, "that the Macedonian was very materially damaged before close action commenced." When the British frigate was completely crippled, the American came to the wind;—the event is well known. As a display of courage, the character of the service, and of the country, was nobly upheld; but it would be deceiving ourselves, were we to admit that the comparative expertness of the crews, in gunnery, was equally satisfactory. My object is to press home the absolute necessity of training to expert practice, master-gunners, their crews, and captains of guns; and I must support my opinion of the vast national importance of such a measure, by a strong, impartial, and unreserved appeal to facts. Now taking the difference of effect, as stated by Captain Carden, we must draw this conclusion—that the comparative loss in killed and wounded, (104 to 12,) together with the dreadful account he gives of the condition of his own ship, whilst he admits that "the enemy's vessel was comparatively in good order,"

must have arisen from inferiority in gunnery, as well as inferiority in force. That our frigate should be captured, was not at all surprising, considering the great odds against her; and the comparative ravages in the two vessels, indicate the disadvantages under which this gallant officer was compelled to engage.

202. In the action between the Constitution and the Java, the same principle of tactic was followed. The Java ran directly down upon the American, to bring her to close action. The Constitution opened her fire at a very long range—avoided close battle for a considerable time—fired at her assailant's rigging—and succeeded in disabling her before close battle commenced. Lieutenant Chads says, "Our opponent avoided close action, and fired high to disable our masts, in which he succeeded too well, having shot away the head of our bowsprit and the jib-boom, and cut our running-rigging so much, as to prevent our preserving the weather-gage." The gallant Captain Lambert had ordered the ship to be laid on board; but the fore-mast being shot away, and soon afterwards the main top-mast, the ship became so totally unmanageable, that his gallant successor could not accomplish what his Captain had designed. The enemy's masts, though severely wounded, did not fall. The

loss in killed and wounded was, according to Lieutenant Chads' account, Java 124, Constitution 58. The American account states 9 killed and 25 wounded, total 34. In this affair, also, the American frigate fought thirty long 24-pounders, against twenty-eight long 18-pounders. Such difference of armament may account, in both cases, for some difference of effect, on masts particularly; for those of the British vessel, being the smallest, were much more likely to be felled by 24*lb.* shot, than the enemy's larger spars were by 18*lb.* balls. But so cautious were the Americans, that even this great superiority of armament was not sufficient to induce them to wave preliminary advantage, and meet at once the offer of close battle. Lieutenant Chad's letter, and the depositions of every witness before the Court Martial, show clearly, that the American, cautiously preserving that distance which best suited the superior powers of his armament, kept edging away, and for a considerable time fought his precision against ours. The loss which the Java suffered in killed and wounded, was chiefly sustained towards the end of the action,after our frigate had been rendered unmanageable:—when this was effected, close battle commenced under those decisive disadvantages that rendered the issue certain.

203. Let us apply these and other actions to what has been said in Case VII. Part II. on the comparative powers of long and short guns; the qualities of long 24-pounders, and their decisive superiority in such distant preliminary operations as those with which the Americans introduced, and will continue to commence, close action. Do not such facts exact, *absolutely*, the timely preparation of means and qualities necessary to attain the most minute precision for distant cannonade, in which superior training is, in fact, superior power; but which cannot be sufficiently acquired in our present system. Do not these and the other facts I have mentioned (Art. 91.) incontrovertibly support my reasoning (Art. 170, 193), as to the vast advantages that may be reaped in distant carronade with powerful guns, directed with every resource of refined, minute expedient, to gain accuracy? The action between the Java and Constitution was also a very gallant display of that undaunted resolution which carried the British frigate forward to dare her antagonist to close action; but this was not a very favourable method of joining in battle with a cautious enemy, who knew well the advantages he might reap by opposing circumspect caution, to the open audacity of his too bold assailant.

204. So much depends upon the way in which a vessel is approached, or brought to action, that I find it impossible to avoid making a few observations upon the tactics of single actions, more particularly as it appears to me, from a close and attentive study of the manœuvres of the American vessels in action with ours, that the tactics of those operations were not matters of chance, nor of individual determination; but a general, predetermined plan of operation, expressly calculated to procure those advantages which our resolute, straight-forward, but not very prudent methods of attack, were expected to present.

In entering on this part of my subject, I am not without apprehension, that I may be considered as touching unnecessarily upon a professional question rather foreign to the subject I profess, and quite beyond my powers. But to bespeak indulgence for this obtrusion, I must submit, that an essay on the service-practice of Naval Gunnery, according to the view I have taken, and to the plan I have followed, is so inseparably connected with tactics, that I cannot, properly, avoid touching upon them, notwithstanding my inability to treat the important subject as it deserves.

205. The form of action which, in tactical

circumstances, has been most unfavourable to us, is the attack from the windward. Of this character were the actions in which the Macedonian and Java were captured. The serious disadvantage of running down directly upon an enemy to leeward, to engage him in close battle, is so obvious, that we can only consider such a plan of operation to have been adopted from the unguarded confidence inspired by those intoxicating circumstances of glory in our naval warfare, which had taught us to despise all manœuvring for position, and to consider circumspection as unworthy of our flag. Guided by such sentiments, it appears to have become an established maxim of the profession, that whenever an enemy can be attacked, the only method worthy of our flag, is, to come at once to the point; and, in their own emphatic terms, to seize the bull by the horns: but this metaphor implies that the excited animal rush also to meet the foe; whereas, in the recent practical illustrations of such a principle of attack, we have seen, that the opposite party, to whom the term would apply, seemed perfectly aware that such a mode of attack would be adopted, but were so coolly and cautiously prepared to receive and prolong it, that this very bold and dignified plan of approach may fairly be con-

sidered to have contributed very materially to the great loss of British blood, if not to that of the material trophies now so proudly exhibited. If this be so, there is abundant reason for endeavouring to bring back that respect for manœuvring for position, which was formerly entertained in the profession, and which is particularly necessary in attacking from the windward; and so to regulate audacity by scientific circumspection, as to know when it is necessary to *blind the bull*, before it is prudent to attempt to seize him. Borrowing an established maxim from the tactics of land operations, to support this admonition, let it be well remembered, that he is considered the best officer, who effects most by manœuvre.

206. There is this fundamental difference, however, between naval and military tactics,—that as great advantages belong to the offensive operations of well constituted, and well commanded armies, so in naval operations the point of attack is so undisguised that the attacking force must be exposed to great, and often decisive, previous effect, if the defensive operation be well managed. That character of generous intrepidity, therefore, which belongs to the commonest person of our nation, and which disdains any thing that can be called foul play,

should, when opposed to an intelligent, cautious, and in force (as it has been) generally superior enemy, be restrained by some circumspection—circumspection ! !—the very word startles me as I write it down ; and it may convey a similar shock to the feelings of those who may read this, and who may also have contemned circumspection in all such cases ; but I have introduced the observation with such support of facts to show that our resolution, courage, and want of circumspection, have materially contributed to the successes of a wary enemy, that I must repeat the admonition. The stigma which senseless men might attach to a prudent observance of circumspection, as to the mode of bringing on close action with a vessel of superior or equal force, should not deter our officers from acting, first, with that discretion which will lead, upon even terms, to a close terminal struggle, in which their native courage will be free from the obligations of caution, and protected from its previous wiles. But to reconcile this to the noble spirits of our glorious navy, without wounding them by any implication, I shall endeavour to show how this contempt of manœuvring for position has been promoted, and why this error ought to have been corrected in some late affairs. In doing this, I shall avail

myself, with infinite satisfaction, of the supporting observations of Sir Philip Broke, the distinguished Captain of the Shannon, (to whom I am greatly indebted for information upon many professional points), and some of which I shall present nearly in his own words.

207. In a great many of the single actions of the late French war, the enemy thought of nothing but escape; or, in bringing on a running-fight, deprived themselves of those advantages which a ship may reap, by coolly awaiting her enemy's approach, with appropriate manœuvre of sail and helm. In such affairs they gave us all that British valour desired—an opportunity of coming, at once, to close action without previous loss, as soon as our vessel could come up with her antagonist. Thus all scientific manœuvre became superfluous; and under such circumstances was properly considered unworthy of our flag.

That the intrepidity of our ancient naval commanders, flourishing also under peculiar circumstances, had given them likewise a dislike of refined manœuvre, is very evident in the pages of our naval history; but this disregard of all caution in approach to action, is only a character of the time, arising out of peculiar

circumstances; and should yield to considerations of a very different nature.

Our most accomplished officers, who commanded ships at the beginning of the last war, not only displayed more caution, in preparing their ships for action, than was subsequently used in a more triumphant period of the naval war; but also held in high respect all scientific manœuvring, with a view to gain the most favourable position for action. That this *was* the professional feeling, is well known—that it *is not* so now, is the consequence of that deterioration in the European navies, which I have already noticed, (page 2,) and which first led us to relax our warlike system, and then taught us to contemn all circumspection.

208. Our modern ships of war, particularly frigates, are not, perhaps, so well calculated for manœuvring as the old-fashioned ships were, being so much slower in turning, on account of their flat futtock, and great length; but any *system* of manœuvring was hardly ever thought of in latter times; and indeed would seldom have been appropriate, sure as we were, that if we could only outsail the enemy, we should be able to bring him to close action on very advantageous terms. Under such circumstances, it would have been absurd, and justly injurious

to a commander's character, to have attempted any manœuvring for advantageous position, even in the most scientific way, when it was in his power to lay his enemy alongside without difficulty. For there is always some danger in bracing and trimming sails, and particularly in backing them, after ships have exchanged a few well-directed rounds, and are under each other's fire. Engaged in such manœuvres, should a chance shot have crippled the assailant, the use the enemy would have made of the accident would have been to escape, in which case a British commander would, justly, have been severely reprimanded, for losing by his theories a victory which the courage and ability of his officers and seamen would have ensured, had they been led at once to an abrupt, impetuous attack. Thus, in our warfare with European navies, the escape of an enemy, after we had brought him to action, was felt by us as a defeat, and indeed they boasted of it as a victory. These circumstances and considerations seem to justify, and even to demand, a bold and uncircumspect approach to that critical position in which, though we might be disabled ourselves, we were generally certain of preventing the enemy from leaving us, having him so much under our fire that any refit would be impossible. Thus

stood the case, as it regarded single actions in general, during the French war; but when we come to meet an enemy so much nearer our own stamp of character, and whose warlike navy (so long as it is in so inferior a proportion to their mercantile navy,) must be well manned; and who will try, in most classes of their ships, to keep some advantage of size and armament;—if such an enemy seek to join science to their other advantages, we must be prepared to answer him in his way, when we cannot have our own.

209. In the tactic of the action between the Guerriere and Constitution, there was a good deal of manœuvring, yet the general courses of the two ships gradually converged towards each other in a degree which admitted of at least an hour's occasional cannonade before close action commenced. The wind was fresh from the north. When the vessels first distinguished each other, the Guerriere was to leeward, close hauled upon the starboard tack:—the American on the weather-beam, standing S.S.W. The Guerriere opened her fire first, (which it is said fell short,*) and soon afterwards the American opened his battery, and continued to fire occasionally as he came down. When he began to

* Upon this fact we intreat reference to Art. 158, Part IV.

draw near the Guerriere, the British frigate wore several times to avoid being raked. This prudent counter-manœuvre, necessary to prevent being raked, operated against closing, which accordingly did not take place till about an hour after the action had commenced. Thus, from the time the fire opened, till close battle began, the vessel, steering free, kept up a sort of running fight upon courses gradually converging towards each other. Various very untoward circumstances conspired to terminate this affair in a very unfortunate manner. Our frigate was very short of hands :—her powder, it may fairly be asserted, from the testimony of the American commander, who says "that her shot fell short," was deteriorated by long keeping and damp.—Several of her guns and carronades broke loose, owing to the perished condition of their breechings, (Art. 189,) and the decayed state of the timbers through which the long-bolts passed. The armament, in guns, (28 long 18-pounders,) was very inferior to the 30 long 24-pounders opposed to her. The loss of the mizen-mast by a chance carronade shot, and its unlucky fall to windward, threw the ship up in the wind in a singular manner; and her other masts, which fell soon afterwards, had been crippled previously by stress of sail, and decay. These

untoward circumstances are quite sufficient to account for the capture of the frigate, and to show, indeed, the impossibility of preventing it, notwithstanding the gallantry with which she was defended; but they are not sufficient to account for the great disparity of loss in killed and wounded, viz. 78 to 14. If I am at all correct in what I have said, in Art. 197, 198, respecting the incredibly trifling effect usually produced by random broadside vollies, given in sudden changes of position, I should say, that in wearing several times to avoid being raked, and in exchanging broadsides in such rapid and continued alterations of position, and consequent elevation of her ordnance, the Guerriere's fire was much more harmless than it would have been, had she given it in a more steady position.

210. It appears to me that the most advantageous way in which a vessel to leeward can receive a direct attack, and bring on close action, with an enemy coming down the wind for this purpose, is to come to the wind herself, and there wait, making as little way as possible, whilst the offensive movement is in progress. This opinion requires some introductory explanations.

If two ships, A and B, Fig. 1, Plate V. move at an equal rate, upon courses equally inclined

to each other, they will approach gradually upon equal terms, and come close to each other, when arrived at C. If the two vessels be equal in force and quality of crew, an action brought on in this way would be alike favourable to both; but if either should possess any superior power of guns, such as might induce her commander to prefer commencing with distant cannonade, and approximate gradually to close battle, then it is evident that the other vessel should vary his plan of operation, to defeat the purpose which his enemy has in view, and which is soon perceptible in his actions.

According to the well known principle of chasing to leeward, the course should be so regulated, that the chase always bear on the same point of the compass. If she be found to draw a-head, the chaser must haul more up: if the chase draw aft, the pursuer must keep more away. Applying this to Fig. 1, the more B draws aft, that is, the slower he goes, the more direct must be A's approach, according to this principle of chasing. Now suppose B, instead of standing-on rapidly in the line B C converging gradually to A's course, were to remain as stationary as possible, keeping her broadside turned towards A; it is evident that A, (whom we suppose desirous of coming to close action,)

cannot approach under the fire of B, without obvious disadvantage. Consequently the slower B moves on the line BC, the more inclined to that line must be the course of A's advance, as AD; and the more he will be exposed to raking fire in coming down. If the ship A be so circumspect as to come down on a line AE, out of range, B should not, upon any account, stand-on to meet him, if the relative force of the ships demand circumspection on the part of B; for doing this would be acting exactly in the manner A wishes, as is evident by such a movement falling in with his plan of attack. But if A come down in any line AD, within range, then B should follow him with his broadside steadily bearing, as F, and in this way should not object to come to close action, the previous advantage having been his.

211. If, having moved upon the line AE, Fig. 2, out of range, the ship A should come to the wind at E on the same tack as B, and there wait, B should then run up to close action, and raking A's stern, as at C, engage him to leeward, if he will permit. If A should decline this, and bear up, as F, Fig. 3, to avoid being raked, B may either do so too, and engage him going free, as at P, on even terms; or stand-on, and crossing his stern at D, keep his wind, and manœuvre afresh.

If A, having come down in the line A E, out of range, should haul up at A 2, Fig. 4, on the contrary tack, B, if he is desirous of close action, should immediately wear, or tack, and stand-on slowly, as B 2. If A keep his wind, B should wait for him, and thus engage to leeward upon equal terms: but if A attempt to bear-up, across B's stern, to rake him in passing to leeward, then B may either bear-up to avoid being raked, and thus, as in Fig. 3, engage A close, going free; or waving this, accept close battle upon A's terms, as the Shannon did the Chesapeake. To execute this, B should not reduce his sail, but by keeping the main-top-sail to the mast, and the others shaking; or, when off the wind, by *bracing-by* as flat as possible, just keep the vessel under the influence of her helm, and no more.

212. But it may be said, a cautious intelligent enemy, attacking from the windward, will come down abaft B's line of fire, Fig. 5, as the Chesapeake did upon the Shannon, and when nearly in his wake, either run up to windward, or pass to leeward, as he may choose, if B will wait for him, or if A outsail B. But whether the action is to be thus fought or not, will neither depend upon B's sailing, nor upon A's pleasure, if B manœuvre properly; for if he have any reason for not desiring such a plan of

action, and should not think proper to give A an opportunity of raking his stern, in passing to engage him to leeward, he should tack or wear at a convenient time, and stand on slowly the other way. Thus, if A, Fig. 6, perceiving B laying to leeward, shape a course to run down into his wake, B should tack or wear in time, and stand on as B 2, towards A 2; and this manœuvre will bring the case exactly to that which has been considered in Figs. 1, 2, 3. If B, neglecting or waving this, stand-on, and let A get close in his wake, then A may bear up, and raking B's stern, engage him to leeward. This is an obvious advantage which the Chesapeake might have availed himself of, (as Sir Philip Broke admits,) instead of ranging up to windward of the Shannon; and it is one which, had it been taken, would most probably have gained some previous advantage. There is no way in which B, having permitted A to come close in his wake, can now avoid sustaining some previous disadvantage, if A should try to rake his stern. For if B tack to avoid it, he will first expose his stern, B Fig. 7, to be raked;—he will be severely punished whilst in stays, by a fire in great part diagonal,—if he hang in stays, he will be utterly destroyed;—and in coming round upon the other tack, he may fall

off, nearly end-on towards A 2, as at B 3. No good officer, indeed, would attempt such a method of avoiding being raked; and if, on the contrary, B bear-up, as B 2, Fig. 8, to prevent this, her opponent A may luff-to, and rake him before B can get away; and then manœuvre for fresh advantage.

Now if, on the contrary, B should have tacked, as suggested in Art. 211, and stand-on towards A, as B 2, Figs. 6 and 9, then, if the offensive movement be continued within range, B should deaden his way as much as possible, and open his fire upon A coming down, keeping his broadside, as at B 3, B 4, steadily bearing; and thus follow the movement of A 2, A 3, gradually, till both ships come close; and thus again I should have no objection to close action, the previous advantage having been mine.

213. If this reasoning be correct, the best way for a vessel B, Fig. 10, to leeward, to receive an attack, with circumspection, from a vessel A, to windward, is, never to let A come down into his *wake:* but having tacked in time, as B 2, stand-on slowly till A approach within B's fire, from which time B should keep as stationary as possible. Supposing the vessels to be of nearly equal force, it may be assumed that A has no intention of avoiding action; but

after he is once brought to the position A 4, it is evident he cannot approach nearer to B manœuvring thus, without receiving a mass of fire which he cannot return. If he shape his course to cross B's bows, the counter-manœuvre which B should apply, is not velocity, but gradual change of position, in steady broadside bearing, with as little way as possible, following A's bow with the broadside, so long as he tries to cross B's bow,—an attempt which can only be continued till A come close to the wind on the larboard tack; and here again I should not object to bring on close action in this way, the previous advantage having been mine. If, in thus rounding-to, the vessels should get foul of each other, it will be in a position favourable to B, as E, F, Fig. 10, if the manœuvre have been properly and steadily executed; and this will bring on a character of combat, (boarding,) which we always desire. These manœuvres will, at all events, refuse to A the opportunities of which we have supposed him to be desirous, viz. previous distant cannonade, on his own terms; and therefore I conceive that this method of manœuvring, in receiving an attack from the windward, is favourable for ships which are not at liberty to receive battle under any disadvantageous tactical circumstances.

214. I am quite aware that there may be difficulties, as well as facilities, in executing these manœuvres, that will require modifications, and, in some cases, perhaps, abandonments, in the theories I have endeavoured to suggest. But many of those cases which demand modifications, or which present facilities, have already been noticed in the several articles which relate to distant practice, close-battle, raking-fire, dismantling-shot, &c. There are, however, some general considerations which it will always be necessary to keep in mind, with strict application to the immediate case, by which the experienced commander will not fail to be correctly guided. From the improved construction of our ships in quality of sailing, they are not so well calculated to manœuvre quickly, as our old ships were. In a considerable breeze, it is extremely difficult to moderate their velocity, when nearly before the wind, by *bracing-by*. This renders it very difficult to keep a free course for any particular bearing of the guns, without either going too fast to preserve that bearing, or yawing frequently. In luffing-to also, our long ships are very slow; and in executing it, run over a great space of water; so that in the smoke of a broadside discharged in this act, there is great risk of a ship getting

a-back, and being obliged to *box-off;* or of losing her head-way, and remaining for a considerable time in this position, which is forcibly termed, being *in irons.* To get her out of this awkward position, the ship must be *paid-off*, by backing the head-sails. This exposes her to the chance of making a strong stern-board (particularly with the fore-sail set), and will, at all events, throw her long *out-of-hand,* before she recovers head-way; and then heavy yards are to be braced round, perhaps under the guns of a closing enemy. Before any manœuvre is attempted, therefore, the actual position of the contending ships—the state of the sea and weather, should be considered; and experience consulted, as to the time the ship may take to tack or wear, compared with the distance the enemy may run in that time; or the time required for the enemy to make whatever counter-manœuvre may obviously suit the case, and the consequent positions to which the two ships will thus be brought.

215. The action between the Macedonian and the United States, was, in tactical circumstances, of a nature different from those cases which have been considered in Art. 210, et seq. The British frigate was to windward, and ran, gallantly, directly down upon the American;

but in doing this, was so severely damaged, that the upper-deck was almost entirely disabled by the raking fire of the United States laying steadily to leeward.

In the action between the Java and Constitution also, the British frigate was to windward. The American vessel tacked and stood away free, soon after she was discovered. At 11 A.M. the Java hauled-up, bringing the wind on the larboard quarter. At 1. 50. P. M. the Java shortened sail, bore down upon the Constitution, keeping her three points upon the lee-bow. At 2. 10. the Constitution opened her fire from the larboard side, and the Java received two raking broadsides before she returned her's, which was not until she luffed-to on the American's weather-bow: but the Constitution immediately wore, under cover of the smoke, and continued to practise this well-known manœuvre, so favourable to lee ships against a direct approach from the windward, until the Java was entirely disabled, when the American came to close action.

216. Now in both these actions there was excess of gallantry on the part of our officers and crews, but very little circumspection; and it is melancholy to reflect that such gallantry should, as it undoubtedly did, tend to such results. If the British frigate had manœuvred, the Ameri-

cans would not have run away. They might have hesitated ere they had met the manœuvre, and joined fairly in close battle; for they only wanted to let our incautious resolution operate, as they knew it would, in their favour. If our frigates had, in both cases, ran down astern, the American would either have tacked or *waited:* if not, they had fled, that's all, and we had triumphed: but no—if we had been *more* cautious, they would have been *less* so. It appears to me, therefore, that we should first have offered battle upon equal terms, by commencing the ordinary manœuvre of running down in their wake. If they had declined this, suppose the Java, A, Fig. 11. had brought-to, as at A 2. The American, B, fancying her rather shy, would certainly, after some time, have approached. This he would have done by tacking, B 2, and standing close upon the starboard tack into the Java's wake, and thence tacking towards her, as B 3. Now, if B tack in A's wake, B cannot go to windward of A, nor rake him, except partially, by luffing-up in the wind, or by keeping away, both of which would be random, and very inefficient vollies (197, 198). But if B should stand on, B 1, Fig. 12, and tack, B 2, to windward of A's wake, then it would be advisable for A to tack also, A 2, because B, by

acting thus, may be suspected of an intention of crossing A's stern G to rake him before he engage him close to leeward, as at D. Now, if A tack, it is evident that upon this course also he will go to windward of B; and if B proceed to B 3, A 3 may lay across his bows and rake him. This B will not, of course, suffer; and to prevent it, must either wear or tack again. If he tack and there wait, as at B 4, A may run up alongside, and engage him to windward at C, in close action; or crossing B's stern, fight him to leeward, as at E; in either of which cases A will accomplish, by previous manœuvre, the very nature of action which he had offered at first, but which B then declined. If, from the position B 2 Fig. 12, B keep away, as B 2 Fig. 13, when he sees that A has tacked, as at A 2, Fig. 12, 13, then A (being still either out of range or at very random distance,) should wear round to engage B, going free, if he goes away as B 4: but if B try to cross A's bows, he should wear round, gradually, deadening his way as much as may be necessary to keep his broadside bearing upon B, as A 5, A 6, A 7; and thus have no objection to close action, either by hauling-up, as A 7, and waiting for B; or by standing-on, A 8, and crossing B's bows to rake him.

217. The action between the Shannon and

Chesapeake reflects upon the victors immortal honour. Its characteristics are, that though the enemy did not, as usual, commence with distant cannonade, yet he was so circumspect in his approach, as not to have been pre-exposed to the Shannon's fire, having come down astern, and only received the fire of the British frigate's after-main-deck gun, and quarter-deck carronade, before he opened his own fire. The rapidity and precision of the Shannon's fire were irresistible;—the enemy was beaten in eleven minutes! Our frigate was admirably managed, and her guns well directed. There was no unnecessary manœuvring: this is only necessary against a cautious enemy manœuvring for preliminary advantage, as in the former actions. But in this action the Chesapeake, confident of success, came fair and simply to the point. If she had not done so, Captain Broke would have out-manœuvred her, and succeeded at long-shot, as well as he did at close quarters; for that officer knew well the value both of gunnery and tactics,—and every quality that should characterize an accomplished officer, and a perfect *man of war*, belonged to that distinguished person, to that ship, and to her gallant crew. Had we a system in permanent operation for training seamen-gunners to such practice, under *naval*

officers, should we find any difficulty in fitting out such a ship? But according to the present system, it can only be where a captain is highly accomplished in warlike science, indefatigable in teaching it, and acting in a long course of war-practice, that we shall find the elements to fit out another Shannon.

I have no doubt that the tactics of these actions are matters which have not escaped the distinguished professional authorities I address, and I should apologize for touching upon them in a paper written for the consideration of the Admiralty; but as these form a very material part of that view of the subject upon which I have committed myself, I could not properly leave them out.

FINIS.

APPENDIX.

A.

Office of Ordnance, Sept. 10, 1817.

SIR,

IN addition to the communcation which the Board of Ordnance directed to be made to you on the 22d ultimo, concerning the cannon and carronade locks which have been altered according to your invention,

I have the honour, by their commands, to acquaint you, that the Lords Commissioners of the Admiralty have transmitted a report from Admiral Sir Edward Thornbrough, on the subject of the trial which has been made with the locks sent to Portsmouth; by which it appears that the locks are considered to be a very great improvement on those at present in use.

I have the honour to be,

SIR,

Your most obedient

Humble servant,

(Signed) R. H. CREW.

Colonel Sir Howard Douglas, Bt. &c. &c. &c.
Royal Military College, Farnham.

B.

Office of Ordnance, Jan. 16, 1818.

SIR,

HAVING submitted to the Board of Ordnance your letter, dated the 15th instant, requesting to be informed of the proceedings which have taken place in consequence of your letter of the 8th November last, respecting the cannon locks of your invention, I have the honour, in reply, to acquaint you that a copy of your said letter, as well as the observations which accompanied it, has been transmitted to the Lords Commissioners of the Admiralty, and that, on a subsequent communication which has been had with their Lordships on the subject, it has been decided that the provision of locks for Sea Service Ordnance now in use, should be discontinued, and those of your invention gradually introduced into the service.

With respect to the measure of appropriating your locks to Land Service Ordnance, as suggested in your letter, dated the 12th September last, I am to inform you, the Board have not signified their orders on that subject.

I have the honour to be,

SIR,

Your most obedient humble servant,

(Signed) W. GRIFFEN.

Colonel Sir Howard Douglas, Bart. &c. &c. &c. Farnham.

C.

From Lieutenant Colonel Sir Alexander Dickson, K.C.B. &c. &c. Royal Horse Artillery.

Valenciennes, 20th April, 1818.

MY DEAR SIR HOWARD,

HAVING fully considered the matter, I feel much pleasure, in compliance to your wish, in being able to state that your proposals for the more extended use of locks, coincide in the most essential points with my own ideas on the subject.

With respect to the employment of the double-flinted lock in the naval service, the benefit is too evident to require any comment on my part, except by expressing a wish that the machine could be treble-flinted to ensure its lasting out any action.

The use of the double-flinted lock with heavy ordnance, particularly in the operations of a siege, presents very great advantages; for by the employment of slow-match only, the fire is frequently retarded, and nothing can be more dangerous than lighted portfires in a battery. I have seen several very shocking accidents occasioned by the use of them, owing to the want of presence of mind of the gunner having

the portfire lighted in his hand at the moment of a shell falling near him. In the sieges I have directed, I have ever prevented, as much as in my power, the use of portfires; but Ciudad Rodrigo was the only operation in which I was fully successful in this respect; and it was to the help of about sixteen or twenty naval gun locks, in addition to the slow-match used, that I was indebted for the vigorous fire kept up in that attack. Your observation with respect to fixing fresh flints in some degree refers to us, as well as to the navy; for I have observed many gunners, when their flint was worn out, have immediate recourse to the portfire or slow-match, never thinking of fixing a new flint, unless obliged so to do, until a pause in the fire gave deliberate time for the operation. Now although no defence can be offered for what evidently arises from want of coolness, still in many situations it may be an object, that the rapidity of the fire should not be interrupted by even so short an operation as changing a flint: the general advantage of the use of locks being, therefore, admitted, *that* to be derived from your double lock becomes the more evident. I trust in future, therefore, that in all siege equipments each piece of ordnance will be supplied with a lock, the use of which, under every circumstance, except in heavy rain, would super-

sede the portfire, which in the very confined situation of a land battery, and where much powder is in circulation, is so dangerous.

On most occasions of this nature, I have, in a considerable proportion, been reluctantly obliged to permit the use of portfires, in consequence of the deficiency of locks, and the delay occasioned by the employment of slow-match.

In the operation of defence also, the same arguments, in a great degree, hold good in favour of locks; and they are truly valuable in coast batteries, and in all night firing.

With respect to their being applied to artillery in the field, I am convinced, that, with a tube such as you describe, locks would be of infinite service with field guns in ordinary duties, such as reviews, firing exercises, and salutes, and in all real service, when not too closely engaged. The effect of the lock being sufficiently certain in these situations, the saving of portfires would be great, and there would be far less risk when in action amongst ripe corn, dry grass, in villages, or amongst houses; for the setting fire to country more generally arises from cutting the portfire, than from the discharge. Although locks would diminish the expenditure of match and portfires, I would not, on that account, propose the conveyance of a less quantity of

those articles than is now practised, for in close action the lock could not be depended on, and in bad weather it could not be used; but allowing the proportions of portfire, &c. to be carried as heretofore, I feel convinced that brigades, in a campaign, would not use half of them: as, however, the proportion, as at present fixed, would take up little room, and as these articles could travel for years without injury, there could be no objection to their continuance *in toto,* as the only augmentation of *materiel* would be the lock and a few flints.

The only difficulty that occurs to me, would be the making the tube, part of which being flexible would be liable to injure in travelling; but Sir William Congreve will no doubt provide for this.

In concluding I have to observe, that I do not mean to resolve the question merely into one of economy, as I deem it on most occasions an effectual simplification of manœuvre, by saving the trouble of continually lighting and cutting portfires, at the same time affording the means of firing with celerity at moving objects.

I remain,

My dear Sir Howard, &c. &c.

(Signed) A. Dickson.

Colonel Sir Howard Douglas, Bart.
&c. &c. &c.

TABLE VII.

Showing the different Natures of Sea-Service Iron Ordnance, with their Length, Weight and Dispart.

Nature.		Length of Piece.		Length of Bore.		Dispart.	Average Weight.	
Pounders.		in.	dec.	in.	dec.	Degrees.	cwt.	qrs.
42	9 feet.						67	0
32	9½ ..	114	·00	107	·2	1½	55	2
	8 ..	96	·0	89	·22	2	49	3
24	9½ ..	114	·00	107	·41	1½	50	0
	9 ..	108	·00	101	·45	1½	47	2
	8 ..	96	·00	89	·5	1½	43	2
	7½ ..	90	·00	83	·42	2	40	0
Congreve's	7½ ..	90	·00	83	·95	5	40	0
	6½ ..	78	·0	71	·79	2¼	33	0
	6 ..	72	·0	57 8	·05 ·82	2¼ Chamber)	31	0
18	9 ..	108	·00	101	·75	1½	42	0
	8 ..	96	·00	89	·74	1½	37	2
	6 ..	72	·00	66	·05	2¼	27	0
12	9 ..	108	·00	102	·23	1	34	0
	8½ ..	102	·00	96	·221	1½	33	0
	7½ ..	90	·00	84	·25	1½	29	2
9	9 ..	108	·00	102	·487	1¼	31	2
	8½ ..	102	·00	96	·48	1½	28	2
	8 ..	No new		pattern.				
	7½ ..	90	·00	84	·435	1½	26	0
	7 ..	84	·00	78	·48	1½	25	0
8	8½ ..	102	·00	96	·957	1½	23	0
	8 ..	96	·00	90	·956	1½	22	0
	7½ ..	90	·00	84	·96	1½	21	0
	7 ..	84	·00	78	·952	1½	20	0
	6½ ..	78	·00	72	·96	1½	18	0
	6 ..	72	·00	66	·97	1½	17	0

TABLE VIII.

Ranges of Sea-Service Iron Ordnance.

Degrees.	42-Pr. Length 9 ft. 6 in.	32-Pr. 9 ft. 6 in.	24-Pounder. 9 ft. 6 in.			24-Pounder. 6 ft. 6 in.		12-Pr. 8 ft. 6 in.	9 Pr. 8 ft. 6 in.
	Charge. lbs.	Charges. lbs.	Charges. lbs.			Charges. lbs.		Charges. lbs.	Charges. lbs.
	14	10—11	8	6	4	6	4	4	3
P. B.	400	350	297	248	265	221	288	300	300
1°	1045	750	720	661	581	582	479	700	683
2	1263	1050	1000	847	777	832	745	913	900
3	1622	1320	1240	1213	925	1133	907	1189	1200
4	1770	1600	1538	1472	1160	1308	1095	1400	1400
5	1938	2085	1807	1590	1371	1545	1259	1580	1622
6	2100	2100	2023	1639	1742	1741	1633	1800	1800
7	2300	2200	2100	1897	1852	2273	1553		
8	2580	2460	2498	2288	2025	2250	2040		
9	2650	2600	2638	2545	2162	2204	2132		
10	2900	2900	2870	2673	2513	2562	2668		

N.B. The 18-Pounder practice is left out in this Table, because it appears to be generally admitted, that it may be regulated by the 24-Pounder Tables, with tolerable accuracy. Some Tables of practice assign to 18-Pounders greater power of range than to 24-Pounders of the same length, similarly loaded; but this may be doubted as a general position, and it will be quite sufficient for common practice to assume them equal.

TABLE IX.

Abstract of the Ranges of Guns Double-Shotted.

The Charges of Powder were the same as with Single Shot. The first Shot was fixed to the Cartridge, and the second strapped to a bottom of Wood set home upon the first.

	Elevation.		Medium Ranges.		Shot struck the Target.				Distance of Target.	Rounds fired at the Target.	Medium Recoil.		Medium of Extreme Range.	REMARKS.
					After grazing.		Without grazing.							
			1st Shot.	2d Shot.	1st Shot.	2d Shot.	1st Shot.	2d Shot.						
	D.	M.	No.	No.	No.	No.	No.	No.	Yards	No.	Yd.	Ft.	Yds.	
Medium 12-Pounder ..	1	30	607	706	1	0	1	1	650	3	8	1		
6-Pr. 7ft.	1	30	621	709	0	0	1	1	600	8	3	2		
6-Pr. 6ft.	1	30	624	765	2	0	0	0	650	10	6	2		
6-Pr. 5ft. 6in. Heavy	1	30	671	814	0	0	0	1	650	10	6	2	1527	
6-Pr. 5ft. 6in. Reduced	1	30	663	821	1	0	2	0	622	4	5	1½		
6-Pr. 5ft.	1	30	586	732	1	0	0	0	537	10	7	0	1475	
6-Pr. 4ft. .... {	1	30	525	716	1	0	0	1	578	7	5	1	1591	
	2	30	657	878	0	0	0	0	800	10	5	0	1629	
3-Pr. Traversg. Carriage	1	30	523	638	1	0	0	2	600	4	1	2½	1505	
3-Pr. Curricle Carriage	1	30	582	699	0	0	0	2	600	7	4	2	1442	

TABLE X.

Ranges with Sea-Service Iron Guns.

NATURE OF GUNS, 32, 24, AND 18-POUNDERS.			
Elevation.	Proportion of Powder.	NATURE OF SHOT.	Range.
			Yards.
2°	$\frac{1}{3}$	With single shot, to the first graze .	1200
2	$\frac{1}{4}$	Ditto . . . . ditto	1000
2	$\frac{1}{4}$	Two shot ranged close together to .	500
4	$\frac{1}{3}$	Single shot	1600
4	$\frac{1}{4}$	Ditto	1500
7	$\frac{1}{3}$	Ditto	2150
7	$\frac{1}{4}$	Ditto	2020
2	$\frac{1}{4}$	One round shot and one round of grape will range with effect together to	600
4	$\frac{1}{4}$	One round of grape shot alone to .	1000
2	$\frac{1}{4}$	One double-headed, or bar-shot, will range to the first graze . . .	800

TABLE XI.

Ranges with $5\frac{1}{2}$ Inch Shells from a 24-Pounder Iron Gun. Length of Gun $9\frac{1}{2}$ feet: Weight 49 cwt. 26 lb.

Elevation.	2 Pounds.			2 Pounds 8 Ounces.			3 Pounds.		
	Flight.	Range to.		Flight.	Range to		Flight.	Range to	
		First Graze.	Extreme.		First Graze.	Extreme.		First Graze.	Extreme.
Deg.	Sec.	Yards.	Yards.	Sec.	Yards.	Yards.	Sec.	Yards.	Yards.
1	1	213	1139	$2\frac{1}{4}$	562	1456	1	277	1424
2	$1\frac{3}{4}$	384	1267	$1\frac{1}{2}$	442	1413	$1\frac{3}{4}$	526	1464
3	$2\frac{1}{4}$	565	1413	$2\frac{1}{2}$	647	1553	$2\frac{1}{4}$	740	1600
4	$2\frac{1}{4}$	750	1479	$3\frac{3}{4}$	896	1639	$3\frac{1}{2}$	880	1679
5	$3\frac{1}{4}$	836	1670	4	915	1510	5	1182	1733
6	4	896	1495	5	1140	1657	$6\frac{1}{4}$	1384	1787
7	$6\frac{1}{2}$	1180	1492	6	1205	1481	$6\frac{1}{4}$	1410	1749
8	$6\frac{1}{4}$	1305	1526	$6\frac{1}{2}$	1259	1544	7	1520	1744
9	$7\frac{1}{2}$	1329	1527	7	1341	1561	$7\frac{3}{4}$	1722	1938
$9\frac{1}{2}$	$6\frac{3}{4}$	1229	1453				$8\frac{1}{2}$	1748	1881

TABLE XII.

Recoil of Sea-Service Iron Guns, on Ship Carriages upon a Horizontal Platform.

Charges of Powder and Shot.	Elevation.	32-pr.	24-pr.	18-pr.
	Degrees.	ft. in.	ft. in.	ft. in.
$\frac{1}{3}$ of Powder and 1 Shot	2	11 0	11 0	10 6
$\frac{1}{3}$ of Powder and 2 Shot	4	19 6	18 6	18 0
$\frac{1}{4}$ of Powder and 2 Shot	7	11 6	12 0	12 0

TABLE XIII.

Ranges with Carronades, 1798. *The Charge is* $\frac{1}{12}$ *of the Weight of the Shot; and with one Shot and one Wad. The Line of the Fire from* 6 *to* 9 *feet above the Level of the Water.*

Nature.	68	42	32	24	18	12
Charge.	lbs. oz. 5 8	lbs. oz. 3 8	lbs. oz. 2 10	lbs. oz. 2 0	lb. oz. 1 8	lb. oz. 1 0
	yards.	yards.	yards.	yards.	yards.	yards.
P. Blank	450	400	330	300	270	230
1 Degree	650	600	560	500	470	400
2 do.	890	860	830	780	730	690
3 do.	1000	980	900	870	800	740
4 do.	1100	1020	970	920	870	810
5 do.	1280	1170	1087	1050	1000	870

Note.—The highest Charge for Carronades is $\frac{1}{8}$ the Weight of the Shot; the lowest $\frac{1}{16}$.

See Observations on this Table, Art. 93, *page* 117.

TABLE XIV.

Experiments on Ricochet, made on Board the Vesuvius Bomb Vessel, by order of the Lords of the Admiralty.

Stoke's Bay, May, 1797.

Ordnance. Nature.	Length.	Weight.	Nature of Ammunition.	Diameter of Shot and Shells.	Weight of Shot and Shells.	Weight of Powder.	Elevation.	Time of Flight to 1st Graze.	Ditto to the Extreme Range.	1st Graze or Fall.	No. of Grazes.	Extreme Range.
	F. I.	Cwt. qr. lb.		Inches.	lb. oz.	lb. oz.	deg.	sec.	sec.	yards.		yards.
18-pr. Carronades.				5·1	17 10		P.B.	,,	,,	345	3	1041
				5·4	17 10		5	,,	,,	1050	,,	,,
				5·3	17 10		10	,,	,,	1728	,,	,,
				5·1	17 8	1 4	1	$1\frac{1}{2}$	,,	472	8	1135
				5·1	17 8		2	$2\frac{1}{2}$	7	652	3	1037
				5·1	17 8		3	$3\frac{1}{2}$	$8\frac{1}{2}$	855	7	1370
	3 1	9 2 21	. . . .	5·1	17 10		5	5	$6\frac{1}{2}$	1163	,,	1223
				5·1	17 9		$12\frac{1}{2}$	,,	11	1950	,,	,,
				5·1	17 8		1	2	$6\frac{1}{4}$	560	4	1122
				5·0	17 8		2	3	,,	670	7	1125
				5·1	17 8	1 8	3	$3\frac{1}{4}$	6	1100	4	1275
				5 2	17 10		5	6	$6\frac{1}{2}$	1280	,,	1.350
				5·2	17 10		$12\frac{1}{2}$	,,	$12\frac{1}{2}$	2235	,,	,,
68-pr. Carronades.			Round Shot	7·86	67 11		P.B.	$1\frac{1}{2}$	8	257	9	1213
			Shell filled with Sand	7·84	43 8			$1\frac{1}{2}$	9	302	12	1365
			Round Shot	7·88	67 12	3 0	5	,,	5	1107	,,	,,
			Shell with Sand	7·84	43 11			,,	5	1140	,,	,,
			Do. do.	7·82	43 11		10	,,	7	1370	,,	,,
			Round Shot	7·90	67 14		P.B.	$1\frac{1}{2}$	8	407	9	1320
			Do. do.	7·87	68 4		1	$2\frac{1}{2}$	$11\frac{1}{2}$	480	12	1887
			Shell filled with Sand	7·83	43 11			$1\frac{1}{2}$	13	358	15	1843
	4 11	36 0 11	Round Shot	7.84	67 11		5	$5\frac{1}{2}$	7	1233	3	1438
			Shell with Sand	7·83	43 11		5	5	$6\frac{1}{2}$	1137	3	1250
			Round Shot	7·87	67 13	4 0	$8\frac{1}{2}$	,,	$8\frac{1}{2}$	1870	,,	,,
			Shell with Sand	7·83	43 12		$8\frac{1}{2}$	,,	$8\frac{1}{2}$	1757	,,	,,
			Round Shot	7·84	67 7		P.B.	1	8	288	6	1112
			Shell with Sand	7·83	43 9			1	7	335	4	1145
			Round Shot	7·84	67 11		$11\frac{1}{2}$	,,	10	2032		
			Shell with Sand	7·85	42 13			,,	10	1767		
10-inch Mortars.		34 2 14	Shell empty	9·84	86 0	5 8	21	,,	$14\frac{1}{4}$	2235		
			Do.	9·84	87 1			,,	16	2510		

See Observations on Ricochet, in Naval Practice, p. 107.

TABLE XV.

Practice with Round Shot fired from the undermentioned Carronades.

Carronades.									Weight of Powder.		Elevation.		1st Graze of the Shot.
Natures.	Length.			Weight.									
Pounders.	Ft.	In.		Cwt.	qr.	lbs.			lbs.	oz.	D.	M.	Yards.
68	3	11	8	29	0	0			4	0	P. B.		154
											1	0	362
											2	0	497
									5	0	P. B.		205
											1	0	444
											2	0	620
									6	0	P. B.		260
											1	0	471
											2	0	662
42	4	3	5	22	1	0			5	4	P. B.		245
											1	0	430
											2	0	650
											3	0	750
32	4	0	25	17	0	14			4	0	P. B.		239
											1	0	380
											2	0	676
											3	0	719
24	3	0	0	11	2	25			3	0	P. B.		218
											1	0	350
											2	0	623
											3	0	664
18	2	4	0	8	1	23			2	0	P. B.		173
											1	0	289
											2	0	524
											3	0	573
12	2	2	0	5	3	10			1	8	P. B.		104
											1	0	237
											2	0	393
											3	0	675

See Observations on this Table, Art. 94, page 119.

TABLE XVI.

Experiments carried on at Woolwich, in July, 1798, to ascertain the Ranges of the Sea-Service Iron Mortars, at 45°, with different Charges of Powder.

N. B.—Cylinder Powder* was used, without Cartridges.

13-inch Mortar.			10-inch Mortar.			Length of Fuze.
Charge.	Range.	Time.	Charge.	Range.	Time.	
lbs.	yards.	seconds.	lbs.	yards.	seconds.	inches.
2	690	13	1	680	13	2·7
4	1400	18	2	1340	18	3·75
6	1900	21	3	1900	21	4·36
8	2575	24¾	4	2500	24½	5·09
10	2975	26½	5	2800	26	5·5
12	3500	29	6	3200	27	6·02
14	3860	29½	7	3500	29	6·13
16	3900	30	8	3800	30	6·23
18	4000	30½	9	3900	30¼	6·33
20	4200	31	9½	4000	30½	6·44

			Cwt.		lb.
Weight of Sea Mortars, Iron, 13-Inch . . .			82		0
——————————— 10-Inch . . .			41		0
Diameter of Shells, 13-Inch,	12·85 in.	Weight	1		5
——————— 10-Inch,	9·85 in.	Weight	0	3	11

* See Art. 162.

TABLE XVII.

Table of English Case Shot for Sea Service.

Nature.	Guns. Weight of each Shot.	Guns. Number in each Case.	Guns. Weight of each Case filled.		Nature.	Carronades. Weight of each Shot.	Carronades. Number in each Case.	Carronades. Weight of each Case filled.	
Prs.	oz.	No.	lbs.	oz.	Prs.	oz.	No.	lbs.	oz.
32	8	70	33	8	68	8	90	46	2
24	8	42	22	15	42	8	66	32	8
18	6	42	16	8	32	8	40	21	4
12	4	42	11	5	24	8	32	16	1
9	3	44	8	9	18	6	31	12	2
6	2	40	5	2	12	4	32	8	2
4	2	28	4	0					
3	2	20	2	15					
1	$1\frac{1}{4}$	12	1	$2\frac{1}{4}$					

TABLE XVIII.

Table of Grape Shot for Sea and Land Service.

Nature.	Weight of each Shot.		Total Weight of the Grape complete.	
Pounders.	lbs.	oz.	lbs.	oz.
42	4	0	46	6
32	3	0	34	1
24	2	0	25	5
18	1	8	19	$15\frac{1}{2}$
12	1	0	10	15
9	0	13	7	6
6	0	8	5	$8\frac{1}{2}$
4	0	6	3	$14\frac{1}{2}$
3	0	4	2	$10\frac{1}{2}$
$\frac{1}{2}$	0	$\frac{3}{4}$ lead	0	$8\frac{3}{4}$

TABLE XIX.

Abstract of Experiments made at Landguard Fort with a 12-Pounder Gun, with Round, and with Oblong Shot. 1776.

Nature of Shot.	Weight of Powder.	Weight of Shot.		Diameter of Shot.	Elevation.	Recoil.		1st Graze.
	lbs.	lbs.	oz.	in.		ft.	in.	yards.
Round . .	5	11	8	4·3	P.B.	4	5	498
Long . . .	5	24	3	4·4	P.B.	7	4	335
Round . .	5	11	9	4·3	1°	4	4	818
Long . . .	5	24	3	4·4	1°	6	2	774
Round . .	5	11	10	4·3	2°	4	6	1413
Long . . .	5	24	1	4·4	2°	7	5	1112
Round . .	5	11	10	4·3	3°	4	5	1410
Long . . .	5	24	2	4·4	3°	6	6	1417
Round . .	5	11	8	4·3	4°	4	5	1549
Long . . .	5	24	2	4·4	4°	6	5	1479
Round . .	5	11	10	4·24	5°	4	5	1789
Long . . .	5	23	3	4·4	5°	6	0	1879

N. B.—Since the MS. of this Work was sent to the press, some experiments have been tried with oblong-*shells*, upon the principle of Shrapnell's shells. Several natures of oblong-shells, more or less cylindrical, with flattened ends and with hemispherical ends, were tried. Those which had the cylindrical part equal to one-third of the diameter, and the ends half spheres, ranged steadily, and succeeded perfectly; from which we may infer that the oblong shot, mentioned in Arts. 39 and 40, might be used with great effect in the manner therein recommended.

TABLE XX.

Table expressing, in English Feet and Inches, the Height, above the Level of the Sea, of the different Parts of French Ships of War, and of their Masts, according to their Rates.

		Line of Battle Ships, of Guns								Frigates, of Guns				Sloops of War, of Guns			
		118		80		74		64		44		36		24		18	
		ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Port-sills	Of the Lower-deck, or 1st Battery	5	7	5	8	5	8	5	6	6	11	6	5	5	10	4	3
	——— Middle do. or 2d do.	12	9	12	9	12	9	12	6								
	——— Upper do. or 3d do.	19	5														
	——— Quarter-deck and Fore-castle	25	11	19	2	19	2	18	11	13	4	12	9	12	0		
	——— Poop (Gunnel)	32	2	25	4	25	4	25	1								
Main Mast	Main Yard	77	0	71	0	66	0	63	0	59	0	55	0	41	0	39	0
	Main Top	91	0	84	0	78	0	74	0	70	0	66	0	49	0	47	0
	Cap of the Main Mast	109	0	101	0	94	0	89	0	84	0	79	0	59	0	56	0
	Main-top-sail Yard (hoisted)	147	0	139	0	130	0	121	0	114	0	105	0	79	0	72	0
	Cross-trees of the Main-top Mast	156	0	148	0	138	0	129	0	121	0	112	0	85	0	77	0
	Cap of Main-top Mast	165	0	156	0	147	0	136	0	128	0	117	0	89	0	81	0
	Head of Top-gallant Rigging	192	0	183	0	170	0	158	0	151	0	138	0	104	0	96	0
Fore Mast	Fore Yard	71	0	64	0	61	0	59	0	51	0	50	0	34	0	34	0
	Fore Top	85	0	77	0	72	0	69	0	63	0	61	0	43	0	41	0
	Cap of the Fore Mast	102	0	92	0	87	0	83	0	76	0	70	0	53	0	50	0
	Fore-top-sail Yard (hoisted)	136	0	128	0	117	0	111	0	101	0	96	0	70	0	66	0
	Cross-Trees of the Fore-top Mast	144	0	136	0	126	0	119	0	109	0	102	0	76	0	70	0
	Cap of the Fore-top Mast	153	0	144	0	135	0	126	0	116	0	107	0	81	0	75	0
	Head of Top-gallant Rigging	176	0	168	0	156	0	144	0	136	0	128	0	95	0	89	0
Mizen Mast	Cross Jack Yard	69	0	64	0	61	0	57	0	52	0	51	0	32	0		
	Mizen Top	81	0	75	0	71	0	67	0	62	0	60	0	39	0		
	Cap of the Mizen Mast	92	0	85	0	82	0	77	0	71	0	68	0	47	0		
	Mizen-top-sail Yard (hoisted)	119	0	110	0	107	0	98	0	94	0	91	0	56	0		
	Cross-Trees of the Mizen-top Mast	126	0	117	0	112	0	103	0	99	0	96	0	61	0		
	Cap of the Mizen-top Mast	133	0	124	0	117	0	107	0	105	0	101	0	65	0		
	Head of Top-gallant Rigging	155	0	143	0	136	0	123	0	120	0	117	0	74	0		

N. B.—The Heights were taken at load water-mark.

For the Use and Description of this Table see Article 171.

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INDEX.

A.

L.

M.

N.

O.

P.

V.

W.

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